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BUILDING PROJECT MANAGEMENT

by

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ABSTRACT

The paper discusses total project management for building delivery, especially as relates to major medical facilities. Project management is contrasted with construction management and a theoretical discussion of management for the integration of all aspects of the building process is developed. The traditional management functions—planning, organization, control, and communications—are described in the context of the building delivery process. A systems approach to management is described and systems theory is applied to the development of a descriptive model of the building process. The descriptive model is based on groups of activities which affect the interaction between four basic resources (time, people, money, and technology) and is used to structure the discussion of organization of the building delivery process. It also provides a framework for describing the case studies which are the conclusion of the report. The case studies are two major hospital projects which are used to combine the theoretical discussion with present practical applications of project management. The case study section summarizes the previous discussion by relating the theory to real situations.

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FOREWORD

Total project management is new to the building industry, and although it has many advocates, it is still not a commonly accepted concept. Project management in the building industry has also not been comprehensively covered in the literature and well defined terminology for describing it has yet to be developed. Consequently, this thesis will be developed from the most basic principles in order to overcome the difficulties posed by the lack of precisely applicable terminology.

The approach was to attempt to synthesize ideas which were derived from the literature of the various disciplines involved. Especially from literature dealing directly with basic concepts of management. The result is the use of many terms which are not commonly related, but this is a logical consequence of discussing a multi-disciplinary activity. Since the objective is to provide a comprehensive description of building project management some of the language becomes more complex than would be necessary in a more generalized description.

The literature search which formed much of the basis for developing this thesis is supported through the use of case studies. The case studies are used to relate the practice of project management to the theory which is developed by this thesis. Hence, the case studies are presented as a summary although many of the earlier conclusions are derived from the analysis of the case study projects.
For clarity the discussion of project management is divided into six major sections. The introduction is a general description of the problem area and puts the concept of project management in historical perspective. This is followed by a discussion of the traditional functions of management. The third section deals with systems theory as it applies to management and provides a framework for integrating the various elements of the discussion. The building process model, developed in the fourth section, provides a generalized framework for describing the activities involved in the building process. The fifth section describes the function of organization and describes various organizational possibilities and the tools for implementing them. Finally, the case studies are introduced as a test for the propositions of the preceding discussion.

The case studies were provided by two professional project management firms. The first is a project of Gerald D. Hines Interests, major Houston based developers as well as prominent project managers. They have been responsible for such projects as: Pennzoil Place, One Shell Plaza, and The Galleria Complex. The second is a project of C. M. Associates, a leading construction management firm which has also developed expertise in the field of project management. C. M. has grown out of Caudill, Rowlett, Scott an architecture firm and is a subsidiary of C. R. S. Design Associates. Many of the procedures which these firms use are incorpor-
ated into the theoretical discussion of project management although they are dealt with more explicity in the case study section.
I: INTRODUCTION

Total project management is the function of managing the planning, design and construction of buildings. It enhances the probability of a project's success by developing and implementing an effective process of building delivery. This thesis describes the function of total project management and proposes that it is a unique and specialized function, necessary to the economical provision of any large scale medical facility.

The increasingly complex process of providing buildings and the high rate of construction cost escalation have led to recent intensive efforts by the construction industry to arrive at controlled, rational processes through which to provide buildings.

This effort has taken two basic trends. The first deals mainly with the technology of providing a building. This trend is evident as the industrialized building approach which simplifies the building process by providing predesigned components which form various building configurations in keeping with pre-set performance standards. This trend toward industrialized building systems has great validity and may become the predominant method of building in the future. There are, however, some basic shortcomings to the concept of simply providing the technology for industrialized building. For example, each building must respond to specific functional requirements and site constraints which need to be
integrated into each building project on an individual basis.

The second major trend in the building industry, total project management, attempts to fill the gaps. This approach to rationalizing the building industry is commonly called project management or construction management. This effort is the main concern of this study. Some clarification of the terms project management and building process is needed especially in light of the preponderant use of this terminology throughout this discussion. "Project management" has been chosen over the more often used "construction management" because of its more general implication. The word "construction" has traditionally been related to the process of erecting the building, and construction management originally grew out of the need to control this process. This fact tends to weight the meaning of construction management toward technological aspects of the process. The label project management, on the other hand, is normally used in industry to describe the function of managing all activities in any process which leads to a single product. Project management is differentiated from other management functions in industry because it deals with a non-repetitive process. As such project management is a very appropriate term to describe the function of all activities involved in building delivery. "Building process" is also chosen over "construction process" in order to suggest a more general application. The term "building process" is used to describe all activities which are performed between the time of formulating the project
up to occupancy of the building. And "project management" will be used to describe the function of managing all aspects of the building process.

This study will examine the building process and describe the elements that are necessary for successful project management. It more specifically deals with the provision of complex health facilities to institutional clients. The project management approach is especially appropriate to this type of project for many reasons. First, the size will financially support expert management consultation during the project. Second, the involved nature of the functional programs for health facilities has thus far defeated efforts to simplify the process, i.e., no total systems packages have been developed for hospitals which are in general use. Third, the rapid escalation of health services costs and health facilities construction costs make time and cost control of the essence. Fourth, the over-all complexity of the project usually leads to a diverse group of specialized participants whose interactions require special management skills. The complexity of the client group itself makes it imperative that specific concern be focused on communications and decision making activities for the process. And, finally, the cost of decision making, which involves many high paid individuals, requires that the decision making process be made as efficient as possible.

Building process management exhibits some characteristics not typical of other process management activities.
Probably the most significant difference between most building projects and typical projects in other industries is that the building owner typically has little knowledge of the technical aspects of the building process or little ability to control the complex process involved. In effect, the owner makes all decisions, and, unless the project manager also owns the project he becomes simply one of the consultants to the owner on management decisions.

The unique aspects of building delivery are another major factor which differentiates it from other industrial production. The C.M. Associates brochure states that "prototypical aspects of building construction cause special management problems," these unique aspects are of major concern to the project manager. The unique aspects of building production arise from two basic facts; one deals with the project team and the other with the actual product. The uniqueness of the building product is a question of esthetic and functional values which will not be specifically addressed here. Still, one of the accepted criteria that client groups use in choosing a design team is that the design team be able to produce a unique building which is especially suited to a set of unique functional and esthetic criteria. Further discussion of the appropriateness of total uniqueness for all buildings can be found in the systems building literature especially Richard Bender's Crack in the Rear View Mirror, where he parodies the building process by comparing it to the manufacturing process for an automobile. Still, the uniqueness of the building product is
an almost universally accepted criteria and one which is emphasized in most building projects.

The uniqueness of project teams is an even more critical factor to project management. Few standing organizations have the capability to deal with all aspects of building a major health facility. Therefore, most project teams are normally groups of organizations specifically selected for the project; the concept of the uniqueness of project team organization is expanded on in Section V. These unique aspects of the building process make it especially inappropriate for the application of management models which are used in other industries.

The systems approach to the management problem is most useful in arriving at a methodology for controlling the building process. Management of any process requires an explicit understanding of the component activities and their interrelationships. Systems theory provides a context for structuring this type of complex problem into a comprehensible framework. The systems approach will take two directions in this paper. On the one hand it is used to provide a tool for describing the building process. On the other hand it offers a framework for proposing a management methodology to be used in the building industry.

Understanding the management function is also basic to this discussion. Management, in a general sense, is concerned with assuring systematic and efficient use of resources. The basic resources involved in the building
The components of the building process are people, time, money and technology. Management techniques must be designed for controlling each of these resources. The people resource requires special emphasis; both because people make decisions and are, therefore, in charge of all other resources, and also because the human resource is the most difficult to manage. The pervasiveness of systems management theory to managing people is supported by Johnson, et al., in their statement that:

The systems concept fosters better control of the most variable and unpredictable resource—people. This occurs because the systems concept identifies the responsibilities and accomplishments of people. When people know their accomplishments can be measured they tend to produce in a more consistent manner. 3

Thus by identifying the components of the building process in such a way that they can be measured the systems approach is used to provide an integrated framework which acts as a tool for planning and control of the process.
II: MANAGEMENT FUNCTION

The role of the project manager is to provide coordination for the building process, and his activities can be broken down into four basic categories – planning, organizing, communicating, and controlling. These functions do not occur in a linear process and it is useful to use a model in discussing the management role. One system for organizing management activities is based on a hierarchical structure for goals, objectives, and program responses. This model provides for a systematic breakdown of the project activities while relating them directly back to project goals and it provides an appropriate take-off point for discussing project management.

It is of primary importance that the objectives for the project be clearly defined. The hierarchical structure suggested above allows for general project goals which are supported by more specific objectives. The process of objective setting can be even more clearly structured if objectives are grouped in terms of the specific resource which they intend to affect. Thus, groups of objectives will center on affecting people, time, money and technology. An example of the project goal might be to construct a hospital that provides health care for a given community. This goal would then be supported by objectives of quality, function and economy which would prescribe the appropriate use for each resource. In turn, one or more response relates to each
objective. The response to an objective is in terms of either an activity or a policy designed to help control activities or resources. Objectives are needed which relate both to the building process and to the expected product.

PLANNING

Planning is the first project management activity, preceded only by preliminary fact gathering. Planning includes projecting objectives from a set of preliminary data and deciding on methods to fulfill the objectives. If looked at in terms of the objectives—program responses tool planning becomes the function of designing the hierarchical network

These objectives and their respondent activities or policies, must relate to specific resources. It shall be shown below (Section IV: Building Process) how a systems approach to the building process will yield subsystems which are based on the interaction between the four basic resources. This section will describe only those activities which fall under the specific heading of project planning.

The most important resource of the building process is people. Objectives ought to be set to allow for the proper interaction of people within the process. Also, objectives need to be set for the appropriate use of people within the finished facility. The response to objectives relating to the process is to organize for effective communication and decision making. The response to objectives relating to the use of people in the finished facility is the functional
program. The time resource requires objectives for the duration of the project as well as objectives relating to the life cycle of the building. These objectives are responded to by scheduling for the various aspects of the project and by life cycle projections relating to the function, and economy of the finished facility. Money requires objectives appropriate to the proper economic use of the other resources. Some activity responses to these objectives are budgeting, estimating, and accounting. Objectives are also required for the proper use of technology. These are responded to by facilities or space programming design services, construction planning and construction.

Planning does not cease after the master project plan is arrived at. As each new activity is entered it must be dealt with on a more direct level than is possible in the master project plan. Thus, planning is an activity which precedes other elements of the process but is also on-going for the duration of the project.

ORGANIZATION

After some part of the project has been arrived at the next management function is to organize a group of people to perform the activities. Organizing a project team from the highly dispersed building industry is an activity of major proportions and a section of this thesis has been devoted to it. Organizing a project team involves arriving at a structure which will make the best use of available personnel, delegating authority and responsibility to the
members of the team, and defining the relationships between them.

CONTROLLING

A third management function is that of controlling the project. The concept of control involves the basic ideas of setting standards, measuring the process, evaluating the measurements against the standards and taking necessary corrective action. The setting of standards is simplified by using the goals-objectives-responsive method. By clearly, and when necessary, quantitatively stating project objectives they become criteria for performance. These criteria are expanded by elements of the project plans such as schedules, budgets and functional programs. Measuring of activities in terms of the prescribed criteria requires a system for collecting information about the different activities, and dispersing it to the proper decision maker this is the communications system discussed below. Evaluation is either a quantitative or qualitative comparison of information received about each activity with the project plan, this comparison leads to a decision being made as to whether or not corrective action is necessary. The effecting of corrective action has the major implication that the controller must have a certain amount of power over the activity which is being controlled.
COMMUNICATIONS

The aspects of measurement and control lead to the discussion of communications which is the fourth major function of management. It is helpful here to make a distinction between two types of activities involved in the process. One group of activities will be referred to as success responsibility activities, the other as implementation activities. The first set of activities generally comes under the domain of the owner and project manager and includes all activities which are carried on simply to assure the success of the project such as objective setting and supervising to assure objective fulfillment. The implementation activities are those which are directly involved with doing the job, for example, financing acquisition, building design, construction. Categorizing activities in this way simplifies the discussion of the communication systems involved in the building process. As has been mentioned above, communication is needed to support the activities of measurement and correction involved in the controlling function of project management. A complimentary system of communication is required for information flow between the various people involved in implementation activities. The communications system is not normally made up of two separate and distinct subsystems as this description might imply, but it is important to have a project communications system which will fulfill these two basic needs.
III: SYSTEMS THEORY

General systems theory has been described as an approach somewhere between the highly generalized approach of mathematics and the highly specific approach of science. The need to reintegrate highly specialized activities of scientists and to do away with the communications gap which specialization caused, led to the development of systems theory. Boulding thus describes general systems theory as "a body of constructs which will discuss the general relationships of the empirical world." This description implies a general overview approach to empirical knowledge, but the construct element involved also makes it very specific, since in order to arrive at a construct specific determination must be made of the elements involved in the construct. The approach of this discussion will not be a general description of systems theory, but rather, a description of the applicability of systems theory to project management.

The systems approach to project management relies on the clear definition of an operational and organizational system for the project team. A system can be defined as "an array of components designed to accomplish a particular objective according to plan." This definition implies not only a group of components involved in activities, but includes the concept of striving for a particular objective. Thus, it supports the idea that systems are described by a set of objectives interrelated by a plan.
The concept of systems can be expanded to include two major categories, closed systems and open systems. A closed system attempts to describe a set of components which are not effectively altered by elements outside the system. The concept of open systems, on the other hand, is much less limiting and more applicable to management purposes. An open system is a system which relates itself specifically to elements outside the system as well as to internal components and their organization. In some respects any system can be defined as either an open or a closed system depending on the attitude of the observer. But, as has been mentioned, the open systems concept is more flexible; it provides a more accurate view of the empirical world and thus will be used exclusively in this discussion.

The theory of open systems describes the world as a hierarchical organization of systems, subsystems and super-systems. Any subunit of the overall system can in turn be described as a system and the outer boundaries of the largest system cannot be determined. Nor can the minutest detail of a system be dealt with effectively. Thus, a person involved with systems design and evaluation must clearly state the boundaries of the system, and the level of resolution with which he is concerned.

This concept of boundaries is critical to the discussion of any system. A technique of describing the system involved in building project management can be developed from the consideration of resources and resource control activities.
involved in the building process. Those elements over which the manager can expect to have direct control will be described as "in" systems; those over which the manager has no control are "out of" systems elements. The boundary between in systems and out of systems elements is only violated by a specific group of definable interactions. This definition of the system involved with the building process is highly appropriate as an aid for concepting and implementing project management. After boundaries are clarified internal subsystems must be defined in a rational useful way; this definition is aided by the concept of subsystems defined by interacting resources.

If a closed systems concept were to be employed systems might be defined in terms of the professions or disciplines involved, but it becomes quickly apparent that this approach would not provide the flexibility necessary for a general discussion. The resource orientation to defining building process subsystems allows for flexibility of discussion as well as providing an effective framework for systems evaluation. This concept will be further clarified in the section dealing with the building process model.

The introduction of the concept of the building model expands on another basic idea to systems theory, that of providing a "construct for the empirical world." In order to discuss the most important aspects of a system they must be identified in a rational framework or construct. Because of the complex nature of most systems the constructs which
are developed for them involve a generalization and simplification of the system. This schematic representation of the system is based on a limited set of characteristics and is called a model of the system. It should be noted that the description of the system in terms of a model is always a restricted view of the system, and the choice of the appropriate model is critical to a systems oriented study. But, as with other aspects of systems theory, the approach to modeling can be hierarchical. That is, a group of models can be described which will collectively provide a better description of the system than any of them would alone. This approach is called simulation. Thus, a complete study of the building process might include models derived from economics, social psychology, decision theory, etc., and a systems approach to combining these models would provide a very accurate simulation of the building process system. The approach to this study is not so broad based; it will simply attempt to describe a model based on activities which control resource interaction, the use of this simple model will allow for a structured description of the project management function.

The description of the building process as an open system necessitates understanding of concepts of interrelatedness and fit. In either evaluating or designing an open system one must consider both the internal elements of the system and its relation to the outside environment. The fit of a system can be evaluated in terms of how effectively the system deals with effects of the outside environment. For example, an
organizational system which requires a particular type of individual who is not available does not fit well into the environment. The system can also be evaluated in terms of interrelatedness of internal elements. For example, an organizational system can be evaluated as to how well the system is interrelated by information flow.

One measure for evaluating a system in terms of interrelatedness relies on the concepts of differentiation and integration. Differentiation is a measure of how many elements a system is comprised of and how similar or dissimilar those elements are. Integration, on the other hand, concerns itself with how well the interconnections between the various elements are effected. This concept is also very important to the systems designer because if he finds that he is dealing with a highly differentiated system, he should be aware that much more effort must be expended in designing the links between subsystems. The concept of differentiation and integration will be discussed further in the section dealing with prototypical organizations.

This discussion of systems theory is meant as an introduction to its dual role in this thesis. First, it will be used to propose a model for the building process which will be used in discussing the management of the process; this model will be developed in the section dealing with the building process model. Second, and more importantly, systems theory is used in developing a basic approach to building project management.
It is proposed that a project manager's function is to design and effectuate a system to complete the project goals. Tilles suggests that a manager's work can be divided into four basic parts:

1.) defining the company (project) as a system.
2.) establishing system objectives.
3.) creating formal subsystems.
4.) systemic integration.

This categorization is in all ways compatible with the breakdown of management activities into categories of planning, organizing, communicating and control. It also fits well with the goals-objectives-program responses model for process planning. An integration of these concepts leads to a systems description of the building project manager's function. System concepting (can also be called planning) is involved with developing the hierarchical framework of goals objectives and program responses, which may be called the system plan. System implementation is the function of organizing individuals and groups to perform the activities described in the program responses of the systems plan. System integration develops the communication network between the various subsystems, and also between in systems and out of systems elements. System control involves collecting information about the system, evaluating the information against the system plan, and effecting corrective change when necessary. Thus, in terms of systems theory, project management is described as a series of activities which attempt to assure the efficiency and effectiveness of the project system.
IV: BUILDING PROCESS

This section will provide a generalized description of the building process from an activity orientation. This basic activity orientation is a departure from the more generally used approach of describing the process in terms of the organizations involved. Katz and Kahn support the more basic activity approach to the analysis when they state that "popular labels represent socially accepted stereotypes about organizations and do not specify their role structure, their psychological nature or their boundaries." On the other hand they go on to say that "the fact that people both within and without an organization accept stereotypes about its nature and functioning is one determinant of its structure." This approach to the process, in terms of the organizations involved, will be covered in the section dealing with prototypical organizations. The supporting concept of this approach is that the building process must first be studied from first principles in order that the implications of popular labels can be better understood.

As has been mentioned in the introduction, this section will develop a model of the building process based on resource interaction. It is suggested that a comprehensive systems oriented description of the building process can be developed using this resource based approach. The purpose here is to describe the building process in terms of its most basic elements.
The most basic categories of resources with which the building process is dealing have already been described as people, money, technology and time, where technology includes all the physical elements that make up the building product, i.e., structure, walls, equipment, etc. It is accurate to describe the process as a series of activities which attempt to assure that these resources are used in the proper way to fulfill the project goals. The Tavistock Institute labels these activities as "resource controller" activities and in generic terms they include the functions of "architect, builder, ...", engineer, subcontractor, etc." A simple comparison of the description of a "resource controller" activity and the previously defined management function would suggest that all activities in the building process can be described as having the characteristics of management functions. It thus becomes apparent that a simple breakdown of the building process into management functions and non-management functions is not easily at hand.

Still, this type of categorization seems necessary to a comprehensive discussion of building process management and the differentiation can be made by using an operational description. The activities which are concerned with planning, organizing and control of the process will be called "success responsibility" activities. This category includes those activities involved with setting objectives, preparing a system to meet those objectives, and assuring that the system operates properly. The other category of activity
will be called "implementation" activities and will include the activities involved in the operational system which is prepared for objective realization. It will be shown that success responsibility and implementation functions exist for each subsystem of activities involved in the building process. It is a unique characteristic of the building industry that the primary success responsibility for most major projects lies squarely on the shoulders of an unknowledgeable owner, and this type of responsibility cannot be successfully distributed to the various knowledgeable participants in the process. This fact is a constant influence on the building process and will be discussed in the section dealing with organizations.

Some of the difficulties in describing the building process, described above have lead to the development of the building process model which provides a framework for discussion and evaluation of the process. One of the prime realizations that must be made in attempting to describe the building process as a system is that the system is not limited to activities performed by the building industry. In fact, some of the more important activities which lead to the completion of a building project have little apparent relation to the building industry. Therefore, a general discussion must rely on broader based concepts than those prescribed by most individuals involved in the building industry. Thus, the question remains, "What are the boundaries of the building process system?"
The answer is made in terms of resources, those resources over which organizations involved in the building process can expect to have direct control are "in" system resources. Other resources or control activities are "out of" systems, but they must be described and related to the project in order to arrive at an open systems description of the process.

Three resources are treated as basic interactive elements, these include people, money and technology. Time, the fourth basic resource, is treated as a framework which acts as a controlling influence on the interactive subsystems described by the other three resources. A schematic of this model is shown below.

![Diagram](image)

This schematic represents an interactive plane including three subsystems, the people-money, the people-technology subsystem, and the money-technology subsystem. The people-money subsystem (A) includes two categories of activities.
The first category involves activities of people acquiring and controlling money, the second involves payment for peoples' services. This subsystem is normally described in terms of the roles of accountants, financiers, and economists. The people-technology subsystem involves activities through which people control the technological aspects of the built product, it also includes considerations of functions of people within the finished facility. This subsystem is the traditional realm of the building industry including architects, engineers and contractors. The money-technology subsystem includes such activities as budgeting, estimating and paying for the technological elements of the built product and is generally in the realm of the construction manager. It should be noted that the description of these subsystems in terms of the professionals who are usually involved is not meant as a generic classification of the system, but is used simply to clarify the concept involved in each subsystem.

The fourth subsystem relates time as an overlay to the three previously described subsystems. This fourth subsystem is somewhat ancillary in that it does not include actual implementation activities. On the other hand, the activities in this subsystem are necessary to the success responsibility function in assuring that implementation activities are completed on time and in the right sequence. This subsystem therefore, becomes of primary importance to the project manager both because of the enormous impact that time has on the cost of a building, and because of the
sequential nature of many activities in the building process. Still in order to fully describe all forces involved in the building process the model has to be expanded to include those out of system factors which impact on the system. The most important of these can be described as either market factors or regulations. Market factors include the availability and cost of the resources necessary for the project at the particular place and time that the project occurs. Regulations include all types of general and special regulations especially building, zoning and safety codes, and types of financing.

Thus, the building process can be described in terms of four specific subsystems and an overall systems boundary. The hierarchical systems description should go one step further in providing a model which is useful as a management tool. This step requires sub-categorization of activities within each subsystem. The subcategorization is made according to boundaries which are described by the normal spectrum of services provided by a particular profession or discipline. For example, the people-technology subsystem will be defined in terms of three subcategories – functional and space program, design services, and construction. This type of subcategorization provides for integration between subsystems designations and a popularly used organizational labels. The subcategories also become a primary level of concern for design or evaluation of the building process system.
It is felt that organizational characteristics of the building process are the most important factors in determining a successful project. Thus, the following section will deal directly with organizational aspects of the process but it is necessary to include a technique in the process model which will allow for comprehensive description of organizational characteristics. The approach to organizational description is derived from the "linear responsibility charting" technique which is referred by Cleland and King in *Systems Analysis and Project Management*.

This technique allows for the description of an activity in terms of all the participants involved. It also allows for a description of the level of participation of each participant. The graphic representation of the linear responsibility chart is in the form of a matrix which has activities on one axis and organizations or individuals which are involved in the process on the other. The cells which define the interaction of a particular participant with a particular activity are either filled in with a symbol describing the level of participation or left blank to describe non-participation of that particular participant in the given activity.

The symbols used express type and amount of responsibility which any given participant may have for any given activity. These symbols are broken down into two basic categories, success responsibility and implementation. Each category is further described by two levels of responsibility.
Thus, the success responsibility categories include: primary decision making responsibility ($\Delta$), and supervisory responsibility ($\Delta$). The implementation category includes: primary implementation responsibility ($\bullet$), and consultation or assistance responsibility ($\bigcirc$).

The linear responsibility charting (L, R, C.) technique serves as a useful management tool as well as providing an evaluation framework for organizational aspects of the building process. Formal relationships between participants involved in any specific activity can be determined simply by scanning the line which describes that activity on the matrix. Furthermore, the subsystems of activities can be scanned for integration or differentiation of organizations involved in particular responsibilities for that subsystem. That is to say, that the project manager can determine how many different groups or organizations are involved with each subsystem. If more than one organization is involved in a subsystem it could mean one of two things to the project manager. The first is that the manager may have to contend with a conflict situation. The second is that the manager may have to focus on internal subsystems integration as well as integration between subsystems. These concepts of organization will be discussed in greater depth in the next section.

The following is a list of subsystems and the activities which they include described in subcategories.
A. Money-People Subsystem

1a. Financial feasibility and cash flow projection
1b. Cash flow accounting
   - income
   - financing cost
   - fees
   - technology costs
   - land cost

2a. Financing proposition
2b. Financing acquisition

3a. Fee budgeting
3b. Fee contract
3c. Fee payment

B. People-Technology Subsystem

1a. Functional programming
1b. Space programming

2. Specifications (performance)
3. Design
4. Construction documents
5. Contracting
6. Construction

C. Technology-Money

1a. Technology budget
1b. Technology estimate
1c. Technology payment

D. Time

1. Money acquisition and cash flow schedule
2. Activity schedule
3. Technology acquisition schedule
4. Regulations

E. Major out of systems elements

1. Market need
2. Area cost factors
3. Area labor factors

4. Regulations
   - restrictions
   - permit payment

5. Legal factors

6. Real estate
   - budget
   - acquisition
   - payment

The assumption for the use of the model specified above is that subsystems categories describe viable groupings of activities. This concept will be discussed further in the next section, but the basic idea is that the activities of specific types of organizations will tend to cluster within specific subsystems. Furthermore, the function of each subsystem can effectively be handled by existing organizations who can be contracted to perform all activities within the subsystem. If this is not the case the project manager must make a special effort to integrate each subsystem as well as facilitating the interface between subsystems. The project manager must also be aware of interfacing with the outside environment.

This type of model also suggests a structure for management activities in that the project manager can structure objectives and responses in accordance with subsystems descriptions. And organizational characteristics can be planned and evaluated in respect to characteristics of system integration and flow.
Organization is the management function which determines interactions between people. Because of the diverse interests involved in the building process, organization is the most important of the management functions. This is especially true since a large number of people are charged with resource controlling activities, each of which has a major impact on the success or failure of the project. The fact that a large number of interdependent activities are taking place in a short period of time adds emphasis to the need for proper organization of building project teams. This becomes an even more critical factor when dealing with an institutional client group, because another level of complexity is introduced. Jim Falick expressed the complexities of dealing with institutional health facilities when he refers to "the unique dotted line organizational structure in hospitals." It becomes the objective of the project manager to discover the organizational characteristics of the client group and to design a project organization that will integrate well with the client's organization. Thus, the goal of project organization is to assemble a group of people who have the required capabilities to assign responsibilities precisely, and to integrate the project team both internally and with relation to the surrounding organizational environment.

Organizational structure is an important factor influencing the function of the organization. There are many facets
of an organization attributable to personalities and capabilities of individuals involved. Each of these attributes, however, is modified to some degree by the structure of the organization; further, organizational structure often determines the effectiveness of individuals within the organization. Organization theory and some elements of information theory, have made it possible to infer certain functional characteristics from the study of organizational structure. Thus, in order to discuss the function of project team coordination certain concepts organizational structure will be introduced.

FORMAL AND INFORMAL ORGANIZATIONS

One of the most fundamental concepts connected with organizations is the differentiation between formal and informal organizations. These two basic types of organizations actually form the ends of a spectrum. The formal organization is highly structured and has the characteristics of defined avenues of communication and interaction; an example is a corporate bureaucracy. The informal organization on the other hand, is loosely structured, and has few determinants to interactions, it is typified by the social group. Most organizations have the characteristics of both categories and this is especially true of building project teams.

The basic premise of this section is that building project teams should be well designed, formal organizations, within which considerations of informal interactions may occur. First, the decision making power is most often
retained by the owner and, therefore, it is hard to estab-
lish another member of the project team as a superior.
Second, the project team members usually have equal profes-
sional stature, thus it is to establish superior-subordinate
positions based on this criteria. The "boss" of the team
will often become the individual who can establish the best
credibility with the client and with other team members. The
tendency to attempt to establish an authority situation
through informal interaction is often detrimental to the
project. This problem ought to be addressed by careful as-
ignment of responsibility in the early stages of the process.

Analysis of the decision making process in formal and in-
formal organizations introduces the concept of differentiating
between leadership and authority. Leadership and authority
both refer to the function of directing an action or decision
making process, but the former established informally while
the latter is a function of a hierarchical organizational
structure. Thus, leadership can be described as the ability
of one individual to influence another, through the effects of
interpersonal relationship. Authority, on the other hand, is
the influence of one individual over another based on a superior-
subordinate relationship in a formal organization. The best
situation is to have the individual with the best leadership
qualities to also be in the position of authority. This factor
should definitely be considered when assembling a project
team. If this situation cannot be established it is essential
that success responsibility functions be appropriately assigned
in order to insure a comprehensible decision making process, and one that is predictable in terms of quality of results.

CHOOSING TEAM MEMBERS

The issue of properly establishing responsibilities is preceded by the need to assemble the project team. This function has a major impact on the success or failure of the project, yet the institutional client often has little or no knowledge of the capabilities necessary for successful project completion. Thus, the client relies on traditional role categories in deciding which type of organizations to hire. This approach can create major organizational problems.

The building industry offers a wide variety of possible organizational structures, all described with an assortment of loosely defined terminology which is open to widely varied interpretation. Increased specialization has caused a breakdown of traditional role categories in the industry, a trend which complicates the choice of participants for the project. Also, umbrella organizations which encompass a wide range of specialities have appeared. These organizations are often labeled with traditional names, such as "Architecture Firms", but often their resemblance to the organizations traditionally described by these labels is negligible. Thus, in attempting to choose members for the project team the client must often compare apples and oranges. The advent of "construction management" and "project management" has confused the issue even more, and it has become increasingly difficult for a client to interpret the jargon which has been introduced by the trend toward increasing specialization.
The client should have available to him a more reliable method of choosing a project team. I feel this method should rely on a previously established project plan. This is frequently a problem because the owner does not have the expertise to establish a project plan. Thus, the owner must select the project team based on selective knowledge of the previous performance of the applicants. As more institutional clients become better acquainted with the need for full scope project management, perhaps such an initial organizational and procedural plan will become a primary element of the building process and a tool for selecting and organizing project teams.

Frequently the method of choosing team members by previous successes is based on inappropriate assumptions. This is especially the case if the previous experience specific to the project type being considered is limited. Applicants for positions on the project team will often represent themselves as having been the "prime movers" on successful projects. However, a look at the building process model will illustrate that it is unlikely that any one participant can assure the success or failure of a project of significant scope.

The question of validity of previous experience is especially important when choosing the project manager. This person will have primary success responsibility for the project. An effort must be made to identify the level of participation which an applicant has had in previous projects.
This is especially necessary since other team members involved in implementation activities may reduce the impact and visibility of ineffective project management. For example, an experienced contractor could overcome the failure of an ineffective construction manager, or the construction manager may provide the management expertise which the project manager lacks. So, while clear cut failure is avoided, the project manager suffers in effectiveness. Information from other participants in previous projects should be evaluated, especially if the applicant has limited experience. If it is found that previous projects were successful because of effective team work, it may be appropriate to attempt to assemble the same project team again.

INTEGRATION OF PROJECT TEAMS

In the process of selecting a project team the question of organizational interaction must be addressed. The team organizer must balance the need for specialized services with a need to simplify the operations of the project team; this question can be addressed through the concept of standing and single use organizations. The standing organization can be described as an on-going organization which is in existence when the project is announced and which is not specifically designed for the project. Single use organizations, on the other hand, are organizations which are explicitly designed to deal with a particular project. The assumption which will be used for this discussion is that standing organizations have the advantage of pre-existing lines of
communication, and therefore, tend to be more highly integrated than do single use organizations.

The concept of "expanded" or "comprehensive" services offered by many standing organizations in the building industry allows for the possibility of highly integrated project teams. Many firms have developed capabilities with which they have not traditionally been associated and which cover a wide range of project activities; thus, the term "comprehensive services". This is especially true of architectural firms, but also includes contractors, developers, etc. Hence, an architectural firm may offer programming, economic counseling and construction management services. The concept of comprehensive services vastly increases the organizational possibilities for a project team.

The building process model described in the previous section can be used to support a systems oriented discussion of organization. The project manager can use the subsystem descriptions to focus on specific aspects of integration and communications and at the same time be able to consider the effects of each subsystem in the context of the organizational system. The implication of the subsystems description is that greater integration is needed within each subsystem than for the overall organization which indicates the need for better and more frequent communications within subsystems. The sub-categories within each subsystem have even more critical requirements for integration. By considering these organizational elements a hierarchy of organizational possibilities can be described in terms of integration.
We can consider an integrated system as one which involves a single standing organization. In light of this criteria the most highly integrated project team would be one in which a single organization is responsible for all activities leading to the completion of the project. In the health facilities field this concept is typified by the operations of a limited group of proprietary hospital chains. The next level of integration would require a single standing organization to be responsible for all the activities in one or more subsystems; an example might be a developer working with a design-build organization. The developer would have responsibility for the people-money subsystem and the design-build firm would handle the people-technology subsystem. The next level of integration would have more than one organization involved in each subsystem; this is the traditional project team organization.

The description of the project team in terms of its integration allows for evaluation of the need for single use communications networks. The more highly integrated organizations will expend less work in establishing effective communications. This factor has to be weighed against the need for a check and balance system which might be required to assure proper performance. A check and balance system can be established by differentiating between organizations involved with success responsibility activities and those responsible for implementation. Nevertheless, one of the biggest factors affecting the success of the project team
is how well the team is integrated. And the number of standing organizations involved will determine the amount of work necessary for establishing an effective communications network.

CONTRACT NEGOTIATIONS AS A TOOL FOR INTEGRATION

Contract negotiations are entered into soon after an appropriate team member is located, with the objective of integrating the participant into the project team. It is during contract negotiations that the responsibilities of each team member are accurately described and the means of reward is agreed upon. Clear documentation of the agreement is critical, especially if future disagreements occur.

Contract negotiation can be described as the attempt to reach a state of accord between parties; this concept of contract negotiations as a reduction of conflict is based on the idea that the objectives of team members are not necessarily the same as the project objectives. Johnson, et al., has labeled differences in objectives the "planning gap", and describes it as:

a divergence in the expectations, premises, objectives, and basic concept which exist between various units of an organization and which prevent an effective well defined framework for integrated decision making. 13

Five factors described by Walton, et al, are said to be the major determinants of conflict within organizations, these are:
a) incentives for sub-optimization which result from conflicts of interest among organizational units.
b) jurisdictional ambiguity because of fuzzy boundaries of responsibility.
c) presence of obstacles to interorganizational communications.
d) existence of social friction between any or all sub-units.

Tuite, et al, lists variables (b) jurisdictional ambiguity, (a) incentives to sub-optimization, and (c) physical and related barriers to communication, in the order given as the most strongly related to interorganizational conflict. The project organizer should be aware of these factors and deal with them effectively during contract negotiation.

It is obvious from the discussion above that the function of organizing must include strategies of intervention which reduce the incidence of conflict. Jurisdictional ambiguity which tops the list as a determinant to conflict is probably also one of the easiest to deal with. The intervention strategy requires a clear description of each activity involved in the project followed by precise assignment of responsibilities for each activity. The latter function is facilitated by the use of the linear responsibility chart. The use of a systematic method for describing project responsibilities will aid in identifying possible conflict situations. Each of these situations can be analyzed in terms of what effect it will have on the project.

The situation of conflict which is brought on by "incentives to sub-optimization" is more difficult to handle. This situation suggests that a participant has an incentive to
optimize an objective other than those specified by the project. For example, a participant may incur greater profit by not optimizing project objectives. Strategies of intervention which attempt to reduce sub-optimization involve the penalty-reward system; this includes not only monetary profit but also more intangible issues of social and legal constraints. The goal of eliminating the incentive to sub-optimization of profit in the building industry is practically unattainable. Thus, social and legal avenues for reward and penalty have been constructed to fill this gap. Codes of professional ethics provide one approach to minimizing this problem. The structure of these codes provide both social and legal penalties for their violation. The social penalties involved, including social censure and loss of reputation, become very viable deterrents to profit sub-optimization if the codes of ethics are properly supported by the professionals involved. Legal penalties are most useful when gross violations of professional ethics occur.

Another legal factor which has been introduced to control the tendency toward sub-optimization is the concept of agency. This involves a legally enforceable commitment of one individual or organization, the agent, to act in behalf of another, the principal. The agent has a fiduciary relationship with the client and is thereby legally required to be fair and loyal to the client. The wide range of activities involved in the building process and the comparative lack of knowledge of most clients make the concept of agency a very important
factor in determining interrelationships between participants in the building process. On the other hand, the involved nature of legal matters and the difficulties of enforcement suggests that other strategies of intervention to prevent sub-optimization are necessary.

The recent trend has been to use the modification of profit motives as a deterrent to sub-optimization. The most potent method for profit motive intervention is the concept of incentive contracting which relies on the idea that the principal will share the savings incurred by the agents performance, with the agent. This concept is based on the fact that the capital expended for professional services is a small percentage of the total capital involved; yet, on the other hand, quality of professional services is a major determinant to the success of the project. The main drawback to the concept of incentive contracting is that it is often difficult to evaluate the value of a particular participant's contribution to the process. Also, when a base level or payment is prescribed it is difficult to determine whether savings incurred through performance of services suggest a higher level of performance that that which is required and paid for under the base rate. Because of these difficulties the trend has been to reduce incentives to profit sub-optimization by means of disconnecting the vehicle of payment from the cost of the project. Thus, "time card", "lump sum" or square footage" contracts are often preferred over "percentage of construction" contracts.
None of the interventions described above provide absolute deterrence of sub-optimization. It is therefore necessary for the project manager to address all factors which may become incentives for sub-optimization by attempting to integrate the objectives of organizations with those of the project during contract negotiations. The objective is to complete "bargaining" activities during contract negotiation so that the rest of the process will be marked by "problem solving" behavior. This introduces a concept which is useful in evaluating the efficiency of decision making which involves the differentiation between "bargaining" and "problem solving behavior". Each of these behavior types has specific characteristics which affect information flow, and both will be exhibited in most interorganizational decision making. The problem solving activity pattern requires that there be no barriers to free exchange of information in the process. Bargaining activity, on the other hand, is characterized by the careful control of information by each of the bargaining parties. In other words, each participant retains a certain amount of information to be used as "hole cards" in the bargaining process. The latter type of activity is highly detrimental to effective decision making. Consequently, a major effort should be made during contract negotiations to establish methods of reward that support problem solving behavior.

The third major determinant of conflict in organizations is the presence of obstacles to interorganizational decision
making. The major obstacle has been discussed in reference to bargaining behavior. Other obstacles include distance between participants, which adds to the cost of communication, and the use of differing technologies for information handling. The cost of long distance communication should be considered in choosing a project team, but this is most often an incidental concern. A more important concern is the difference in communications technologies. It is the responsibility of the project manager to set up an integrated communications network which assures that each participant receives the proper information, at the right time, and in a form that he can understand. The participant must also be able to store that information in a way that makes it accessible to future use.

One technique which has been developed for effective project communications is the project manual. The project manual involves a notebook which includes a prescribed set of forms that cover the range of necessary information flow, it also acts as a filing system which is used to order the information. The project manual approach acts as a tool for discussing communications which will be necessary during the project. It also provides a technology for structuring and controlling information flow.

Another tool for information handling involves the use of a computer and remote terminals. This technique is presently being used to provide on-site access to complex information which relates to schedule and budget control. It seems possible that the use of computers can be expanded to
include a greater scope of information handling in the building process, especially in light of the advent of interactive software packages which can be accessed from remote terminals. The ultimate, if presently impractical, method for information handling would involve a central computer file of all information pertaining to a project which would be equally accessible to all participants.

PROTOTYPICAL ORGANIZATIONS

The traditional project organization includes three major participants: the owner, the architect/engineer and the contractors. Recently a fourth major participant, the construction manager, has been introduced to many large projects. These four major participants can be arranged into various organizational structures.

The most traditional organization has the architect in a direct line between the owner and the contractor. In this type of arrangement the architect acts as the owner's agent in both the design and construction stages. Hence, it is the architect's responsibility to supervise the construction process in the owner's behalf. Recently, architects have reduced their involvement in construction supervision because of the rise in third party liability claims. This causes owners to have to rely more on contractors' reputations than in the past when they were more closely supervised.

Most recently, the complexities of the construction practice have opened the way for a new type of professional
organization, the construction manager. Construction managers have assumed many of the responsibilities which were originally the architect's. Also, in many cases, construction managers have assumed the function of a general contractor. Because of the quasi-defined nature of construction management many different organizational possibilities have cropped up.

Project management is one of the primary functions which has been assumed by construction management firms, although the activities involved have yet to become attached to any particular type of firm. Architects, management consultants, or owner groups are just as likely to have the expertise available to perform effective project management. The most feasible organizational structure for effective project management is shown in Figure 2. In this situation the project manager assumes success responsibility functions over most of the project activities.

The other major role which a construction manager can have requires an expert in the construction process. In any of a number of different arrangements the construction manager becomes a coordinator between the design process and the construction process; some of these arrangements are shown in Figures 3, 4, and 5.

Figure 3 shows the construction manager at an equal level to the architect/engineer. This type of arrangement has the advantage of providing the owner with two primary sources of expertise. It has the disadvantage
of setting up a conflict situation between the A/E and CM; since neither is in an organizationally superior position the owner must take a primary position in the decision making process. If the owner has the time and capability he could well use the intrinsic conflict situation to his advantage.

Figure 4 has the construction manager as a consultant to the design and construction process; this is probably the least effective arrangement. Here the construction manager has no real responsibility for implementation activities and it is difficult to establish credibility in such a situation. The advantage is that the arrangement introduces a source of knowledge which may not be represented by the major participants.

Figure 5 represents the architect/engineer and construction manager as being encompassed by one firm. This has the advantage that intraorganizational communications and decision making systems are established before the advent of the project and conflict within that organization is not explicitly the owner's problem. Hence, the owner has fewer organizational problems to contend with. On the other hand, the success of the project is controlled by a single firm and the owner must indulge great confidence in that firm.

The linear responsibility charts which are presented after the organizational diagrams are meant to describe the various arrangements in more detail. They represent activities in which each organization is most likely to be involved.
**Fig. 1 Traditional Organization**

**LINEAR RESPONSIBILITY CHART TO ACCOMPANY FIGURE 1**

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<tr>
<th>ACTIVITIES</th>
<th>Owner</th>
<th>Project Manager</th>
<th>Construction Manager</th>
<th>Architect/Engineer</th>
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**Fig. 2 Project Manager as surrogate Owner**

**LINEAR RESPONSIBILITY CHART TO ACCOMPANY FIGURE 2**

<table>
<thead>
<tr>
<th>PARTICIPANTS</th>
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<th>Project Manager</th>
<th>Construction/Engineer</th>
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**LEGEND**
- Decision Making ▲
- Supervision ▲
- Implementation ●
- Consultation ○

49
Fig. 3 Construction Manager and Architect Engineer separate but equal

**LINEAR RESPONSIBILITY CHART**

**TO ACCOMPANY FIGURE 3**

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**LEGEND**

- Decision Making ▲
- Supervision ▲
- Implementation ●
- Consultation ○
LINEAR RESPONSIBILITY CHART
TO ACCOMPANY FIGURE 4

PARTICIPANTS

ACTIVITIES

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<th>Construction Manager</th>
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| PEOPLE-TECHNOLOGY SUBSYSTEM |       |       |       |       |       |
| Functional Programming    |       |       |       |       |       |
| Space Programming         |       |       |       |       |       |
| Specifications            |       |       |       |       |       |
| Design                    |       |       |       |       |       |
| Construction Documents    |       |       |       |       |       |
| Construction              |       |       |       |       |       |

| MONEY-TECHNOLOGY SUBSYSTEM |       |       |       |       |       |
| Technology:                |       |       |       |       |       |
| Budget                     |       |       |       |       |       |
| Estimate                   |       |       |       |       |       |
| Contract                   |       |       |       |       |       |
| Payment                    |       |       |       |       |       |

| TIME-CONTROL SUBSYSTEM     |       |       |       |       |       |
| Cash Flow Schedule         |       |       |       |       |       |
| Activity Schedule          |       |       |       |       |       |
| Technology Acquisition Schedule |       |       |       |       |       |

| MAJOR OUT OF SYSTEM ACTIVITIES |       |       |       |       |       |
| Market Need Study           |       |       |       |       |       |
| Regulations Interaction     |       |       |       |       |       |
| Legal Services              |       |       |       |       |       |
| Land:                       |       |       |       |       |       |
| Acquisition                 |       |       |       |       |       |
| Payment                     |       |       |       |       |       |

LEGEND

Decision Making ▲
Supervision △
Implementation ●
Consultation ○
**LINEAR RESPONSIBILITY CHART TO ACCOMPANY FIGURE 5**

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Figure 6 shows one of many hybrid possibilities, in this situation the project manager acts as a surrogate owner and is backed up by a separate construction manager. Case study 2, presented in the last section of this report is an example of this type of organization.
TYPES OF CONTRACTS

Along with the wide choice of organizational structures the client also has a diverse group of contractual arrangements to choose from. Although there are many possibilities, four major types of contracts predominate the building industry, these are: Lump Sum, Cost Plus, Percent of Construction, and Unit Price Contracts. Each of these is applicable to relations between the owner and any participant in the project, although some have traditionally been reserved for specific uses. Still, the changing nature of the building industry is causing traditional guidelines to break down. Consequently, it is valuable to deal with contractual arrangements in terms of general aspects of each type, present applications, and effects on organizational processes.

The first type is the lump sum contract which has traditionally been used in engaging contractors. In this type of contract a description is made of the work required; the applicant makes an estimate based on that description and states a price which is either accepted, rejected or negotiated by the owner. This type of contract has little effect in reducing conflict between the participants' objectives, and the project objectives. One negative factor is the uncertainty involved in estimating the job requirements, either when contracting for architectural services or for construction, the job can never be fully described. The competitive nature of the bidding process which is often used in establishing lump sum prices also has a detrimental
effect. If the participant has made a bad estimate or is forced to bid too low because of competition and starts to lose money on the project, the quality of the project may suffer. And in the construction process the contractor may attempt to use change orders to increase his profit. On the other hand, competition tends to reduce prices and it is often necessary to obtain an accurate estimate of the cost of services. Hence, lump sum contracts are often very appropriate but care must be taken to establish clear understanding of the scope of the project and extent of services required.

Cost plus contracts have been used primarily for small construction projects and for many types of architectural and consulting services, including construction management services. This type of contract established a payment scale based on a multiple of actual expenditures; the multiple is added to cover overhead and profit. This seems to be an excellent way to reduce conflict between participants and project objectives because the participant is guaranteed a profit for each unit of work which he performs. But careful attention must be focused on accounting procedures in order to insure that expenditures recorded are actually applied to the project.

The percent of construction contract is strictly limited to contracts for services. It implies that the participant will be paid a set percentage of the final construction costs. This type of contract causes serious problems, mainly that there is a conflict of interests between a participant's
responsibility for cost control and the fact that his fee increases as the cost increases. Also, the cost of construction is not an accurate indication of the amount of effort involved in performing architectural or consulting services. Hence, it is slowly being replaced by other types of contractual arrangements especially in major construction. Its major strong point is that by tying the cost of services to construction costs it provides a simple method for estimating the combined costs, once the construction cost estimate is made.

The final type of contract is the unit price contract which is a modification of the lump sum contract. Under this arrangement payment is based on a price for some basic unit of product; the unit can be anywhere from a square foot to a complete building. Unit pricing has provided an effective method of contracting for services. For instance, an architect can do a historical study of his cost per square foot of building for providing services related to a specific building type, the fee can be projected from these historical costs. Thus, if the scope of the building is increased the architect is still paid a fair price. The fee mechanism should be related to each step of a process, i.e., schematic design, design development, etc., in order to provide flexibility. This type of contract is not possible if the participant does not have accurate information relating to the cost of services for the specific building type involved.
VI: CASE STUDIES

The use of case studies drawn from the recent experience of professional project management firms provides a practical basis for evaluating the applicability of the concept of total project management. Hence, two projects which are examples of the application of project management are introduced. The discussion is focused on the primary aspects of planning, organization, communications, and control and on specific techniques which are useful to effective project management. Consequently, the case studies become the primary vehicle for understanding the practical impact of total project management.

Two hospital projects were chosen as case studies because their complexity made project management a necessary element to successful completion. The first project is a new facility in a large city while the second is a major addition to a hospital in a small town. Both are community non-profit hospitals which are well established in their respective communities, and the new facilities are to be financed through the sale of tax free revenue bonds. Hence, financing regulations are a major factor in establishing a project plan. Although from this description the projects seem to be very similar the processes involved in each project are markedly different.

The new facility which is presented as the first case study is a replacement for the existing central hospital of a community wide hospital system. The building process is
unique in that a project manager was engaged in the very late stages, thus, the project must be discussed in two parts. In the first phase of the project the client group took on the functions of the project manager; the client felt that since they had recently built a number of suburban neighborhood hospitals that they were fully capable of performing in the capacity of project manager. Hence, the project proceeded for over three years without the involvement of a professional project manager; the full project duration is now projected to be seven years. After three and one-half years serious budgetary problems were discovered and a project manager was engaged to rectify the situation. The period after the hiring of a project management firm is the second phase of the project. The project manager was instrumental in reorganizing the project and directing it toward a successful conclusion.

The second project was well planned and executed from the beginning, and it exemplifies many of the better attributes of project management. Here the client retained the decision making functions while engaging a group of specialists to perform most implementation functions. The result was a very capable, if somewhat unwieldy, project team. The unwieldy nature of the project team was caused by the presence of three major participants of equal status. The determination of which of the three (project manager, architect, or construction manager) was the project leader was never precisely established. This led to ineffective decision making
by the project team and required a lot of involvement from
the client group. This did not become a major obstacle since
the client group was able to supply the time that was required
of them. Consequently, the effective integration of all mem-
ers of the project team, including the client, led to a
successful project.

Use of the building process model will facilitate the
discussion of the case studies. The process will be de-
scribed by the use of two charts, the linear responsibility
chart and the activity schedule. These charts are organized
in accordance with the structure which is set up by the pro-
cess model and, when used simultaneously, they serve as
effective tools for evaluating the process of each case study.
(The charts for each case study are presented at the end of
the discussion.)*

The linear responsibility chart (L. R. C.) is a matrix
which relates participants and the various activities in
which they are involved. It can be used in evaluation the
project team organization. The L. R. C. identifies conflict
situations which are related to imprecise assignment of
responsibility, as well as, identifying activities for which
no participant has responsibility. Also, by simply scanning
the chart, the project manager can get a feel for the effort
which will have to be expended in integrating the project
team. For example, if he finds that many participants are
involved in a particular subsystem the project manager will
know that that particular subsystem will require careful

*The project schedules appear in Appendix A
attention to communications and integration. The characteristics of the L. R. C. make it especially useful when integrated with the project's activity schedule.

The activity schedule depicts the duration of each activity required for completion of the project. The activities are categorized according to the process model, and interrelationships between activities are described by lines of communication. The concept of breaking up the process into activities and events is borrowed from network scheduling methodology in order to facilitate the description of the process in terms of specific sub-units of activity. An event is a point in time where communication between activities occur and an activity is the function leading to an event. The activity schedule shows activities as lines which connect events (dots). Communications functions are shown as dashed lines between events. The length of the solid lines between events is a measure of the approximate duration of activity; for simplicity, however, communications functions are shown without duration. The time and difficulties involved in decision making and communications are further described in the narrative.
CASE STUDY I

The first case study involves the building of a new five-hundred bed tertiary hospital. The discussion will focus on the period between the hiring of the architect and the bid opening for the general contract. This project is discussed in two stages because of the late entry of the project manager.

In the first stage the major participants were the owner, the hospital consultant, and the architect. Significant effort toward concepting the project had been expended before the architect was hired; consequently, the hospital consultant had more impact on shaping the building than did the architect. Previous to the hiring of an architect, a feasibility study had determined the need for a completely new facility, a site had been developed. In fact, the initial program included patient room and nursing unit layouts which effectively established the schematic design. A preliminary budget for the facility had also been established, but had never been accurately related to programmatic requirements. One of the strong points of the project, however, is that objectives for operational cost savings were set early in the project. Consequently, the initial program requirements included a wide range of labor saving systems which were to be included in the new facility. The idea was to trade first costs for operational costs which is a valid concept for health facilities.
The entry point of the project manager is the most unique aspect of the organization of the project team. The project manager was engaged over three years after the initiation of the project, just before the final design development stage. Often a construction manager is hired as late or even later, but in this case the firm that was engaged was charged with full project management responsibilities. In other words, they took over a majority of the functions in both the people-money and money-technology subsystems, and assumed success responsibility functions in the people-technology subsystem.

The entry of the project manager was precipitated by the need to cut costs which was discovered when the final schematic design estimate was compared with the facility budget. Thus, the first responsibility of the project manager was to evaluate the process which had preceded his joining the project team. This served the purpose of integrating the project manager into the process and also allowed him to establish the real nature of the problem situation.

The major element of the problem was caused by ineffectiveness and lack of integration in dealing with financial matters. Not only was the budget not realistically established in relation to an accurate market need study, but the full ramifications of the cost of the facility were not discovered until late in the project. This problem was caused by the incapability of the owner to handle the major role which he had prescribed for himself. The owner was
neither able to acquire as much financing as the budget required, nor was he able to help the architect cut costs. This situation was further complicated by the long duration of the project which allowed cost escalation to eat up a large part of the budget.

The other element of the problem involves the relationship between the architects and the hospital consultants. By including a schematic design of the nursing unit in the initial program package the hospital consultants overstepped their charge as programmers. This caused a conflict situation between the architects and the hospital consultants. Also, since the building layout was effectively established, normal cost control and value engineering functions which are the responsibility of the architect were made ineffective. This situation was probably enhanced by the status of the architects as relative newcomers to the health care field. Although the architects are very competent it was difficult for them to establish as much credibility with the client as had the more well established hospital consultant. Thus, the apparently less competent hospital consultants had more effect on the design than did the architect.

The solution to both elements of the problem involved the hiring of the project manager. The project manager was responsible for establishing a new more realistic budget and for cutting down the program to fit that budget. Another function performed by the project manager was to evaluate the building design on a system by system basis and to
optimize each of the systems involved. This led to considerable reductions of the cost of the total building. Consequently, a realistic balance was achieved between a reasonable level of financing, the project budget, and the estimated cost of the facility.

The major factors which determined the success of the project manager were competency and status. The firm which was hired as project manager is capable of performing a wide range of implementation activities. They also have broad based experience in evaluating functions which they do not have the internal capacity to perform. Also, the internal organization of the project management firm is specifically designed for building process control; this leads to a project organization which is highly integrated for decision making. Still, the status of the project management firm was a necessary factor in establishing its effectiveness.

It is interesting to note that the specific constraints of this project did not allow the project managers to implement many of the methods which they normally use for cost control. Yet, they were successful in receiving bids which were well within the budget. Because the project was to be financed through the sale of tax free bonds, it had to be built under one general contract. Therefore, bid packaging and phased construction were impossible. The use of public moneys also did not allow for negotiation of contracts. Consequently, the contract price was set by means of a lump-sum bid.
Thus, in order to establish an effective method of price control the project team had to work with only a few of the tools which would normally be available to them. Primarily, they relied on optimizing the design of each part of the building. It was probably more important, however, that they made sure that the contractors clearly understood what they were being asked to bid on. This was done by preparing a good set of construction documents, and by discussing them with the contractors in pre-bid conferences. Consequently, the contractors were able to bid the job intelligently and all bids were within six percent of the final estimate.

The project manager was also effective in helping the client to establish a realistic budget. A new estimate of the market for services was established through the collaboration of the owner and project manager. And, the project managers established a new budget based on the market, the cost of financing, the projected operational costs and the cost for the facility. Thus the project managers were instrumental in integrating all activities of the process which are involved with money.

Still, the greatest effect that the project manager had was to integrate the project team under the leadership of a highly capable organization. This success was primarily based on the reputation of the firm as an effective professional organization.
# Linear Responsibility Chart

## Project One Phases One

### Participants

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- Decision Making: ▲
- Supervision: ▲
- Implementation: ●
- Consultation: ○
## Linear Responsibility Chart
### Project One Phase Two

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- Supervision △
- Implementation ●
- Consultation ○
CASE STUDY II

The second case study involves a major addition to an existing community hospital. This project was well concepted from the beginning and has no serious problems; it represents almost a model project. Still, there are few minor discrepancies in the organizational and procedural aspects of the process, although, generally, these discrepancies have been well handled by the individuals involved.

The most unique aspect of this project is the presence of both a management consultant and a construction manager. This is also the factor which has caused the greatest difficulty. The problem arises from the fact that the management consultant has been placed in an authority position, yet the construction manager has greater expertise in the building process. Hence, decision making is clouded by the lack of a clearly defined mutually acceptable leader. Consequently, the responsibility for decision making is deferred directly to the owner even in many minor situations. This situation is not critical since the client is a reasonably effective decision maker; still, much effort is wasted in abortive decision making attempts between the other participants.

One of the strong points of the project was the close attention to detail which was evident from the beginning. This attention to detail led the client to assemble a very complete, if somewhat unwieldy, project team. As can be seen from the linear responsibility chart, every principal activity has been assigned, generally to specialized organizations.
Some situations have resulted in conflict, but a precise description of roles and appropriate interventions by the owner have limited conflict or made it useful when it occurred.

One obvious conflict situation existed between the architects and the construction managers. They were mutually charged with establishing design standards for the project. The conflict situation arose from the two organizations having different primary objectives. Whereas the construction managers' primary objective was to control the cost of the building, the architects were most interested in producing a functional and esthetic product. Although these two objectives are not necessarily opposites, they are definitely not parallel and conflicts did occur. These conflicts were solved through mutual cooperation and actually led to a better product.

The most prominent example of the conflict between the architects and the construction managers relates to the cost benefit analysis of the nursing units. The design of the nursing units as proposed by the architects was not initially accepted by the construction managers as an optimal solution. The architects did not agree with the construction managers' conclusion and performed their own evaluation. It turned out that by closely evaluating all the factors involved the nursing unit plan was shown to be much more efficient that the construction manager had presumed. This evaluation also turned up specific problem areas which were subsequently worked out through collaboration of the architects and construction
managers. Careful attention to specifying responsibilities was helpful in establishing a working relationship between participants which led to problem solving behavior.

However, in the situation involving the management consultant and the construction manager, conflict was never totally resolved. The situation was even further complicated by the presence of the architect as an equal participant in the process. The hospital consultant could be considered as another major participant, but because of the close ties between the management consultant and hospital consultant they will be considered to be one organization. Thus, the major problem arises from the attempts by three professional organizations, of approximately equal stature, to establish themselves as the project leader. This situation is the result of the lack of a clear definition of authority. Because of this situation few decisions were made at team meetings which were not attended by the owner.

COMMUNICATION

Reference to the linear responsibility chart reveals a highly differentiated project team. This situation poses a communications problem which was well handled in this project through the use of team meetings. Project team meetings at critical points in the project provided an effective method for team integration. The meetings had a prescribed agenda and were controlled by the client; this made for efficient use of the client's time. The meetings were also helpful in establishing deadlines for major portions of the process.
The deadlines for different activities were related in order that any major decision could be made in terms of its effects on other elements of the process. For example, the decision on the acceptability of the schematic design, based on the estimated cost, could be made in relation to the existing situation of obtaining financing for the project. Another benefit of the project meetings is that the minutes of each meeting became an effective record of decisions.

Another technique which was introduced to aid communications was the project manual which provides a specific set of documents to be used in the communications process. The manual is a loose-leaf notebook with dividers and the various documents are filed in their respective sections (the labels for the various sections are reproduced in the appendix). This common filing system facilitates referral to previous communications, especially in carrying on long distance telephone communications. In this case the project manual was primarily used for information relating to construction management, but the notebook could easily be expanded to include a majority of the building process.

Cost control is another function which is specifically related to the construction management of the project. It is the construction manager's responsibility to assure that the cost of the project is within the bounds specified by the project budget. A very systematic and effective method for cost control was used in this project and it deserves special consideration.
# Linear Responsibility Chart

## Project Two

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<th>Activities</th>
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### Legend

- Decision Making ▲
- Supervision △
- Implementation ○
- Consultation ◆
COST CONTROL

Cost control methods for building projects proceed from the general to the specific. Consequently, initial estimates are based on general historical data which is later modified by more current and specific information.

The initial step in the cost control process is to establish whether or not the project is financially feasible. This requires a market study to determine which services are required followed by an economic analysis based on the projected income from those services. The initial project budget is established by relating the cost of the facility to its ability to produce enough income to retire the debt which is incurred in constructing the facility, as well as to pay for operational costs. In the case of community hospitals the budget must also project the level of funding which will be acquired through donations. This becomes one of the more arbitrary and difficult to establish elements of the budget. In fact, overly ambitious projections for donations caused the budget to be cut back in the later stages of both case study projects.

The clarification of the project budget in this project was facilitated by a historical cost program called "BLITZ". This program produces a list of completed projects which are similar to the one under consideration listed by square foot costs. An assumption is made that the higher cost buildings are of better quality and the list is broken up into various quality categories.
By relating the program requirements to the budget a preliminary square foot cost estimate is arrived at. This estimate can then be compared to the BLITZ list. The comparison will suggest whether the projected square foot cost estimate is reasonable and what kind of quality can be expected. This process may lead to modifying the program or quality expectations in order that the square foot costs be more in line with historical precedents.

The next step in the cost control process is to produce a site and program specific estimate. In order to do this the construction manager employs a technique called the "building model study" which involved producing a physical concept for the building. The extremely schematic drawings are then used in establishing an estimate. Since the architect is reluctant to commit himself this early in the project, the construction manager is forced to provide the physical concept for the building. This is done with collaboration of the architect, and an attempt is made to coordinate the building model study with some of the architect's own concepts. The estimate involves a takeoff of materials for exterior walls, roofs, and site improvements, other costs such as interior partitions and air conditioning systems are established from historical data. The information derived from the building model study is then compared with the established budget; if the estimate is higher than the budget the program must be modified. Various alternatives for modifying the budget are arrived at and one is chosen by the client.
The steps which follow the building model study involve estimating after each design milestone, i.e., schematic design, design development, and construction documents. The construction manager attempts to integrate information from various contractors into the design process, thereby limiting the deviation between the estimate and the budget, and more importantly, between the final estimate and the bid. In conjunction with estimating and value engineering the construction manager must also assure that the project takes advantage of external market factors. This is partially done by interviewing contractors and suppliers to determine their capabilities; thus, the design can be matched to the available technology.

Another method of relating to the market is to break up the job into various contract packages. Smaller packages make the jobs available to a greater number of contractors, thus increasing competition and lowering prices.

Bid packaging is also an essential element of fast-tract scheduling. Breaking up the process into sections allows for the different sections to be carried on simultaneously rather than sequentially; consequently, the overall duration of the project is shortened. By shortening the duration the effects of inflation are decreased as is the effect of indirect costs, i.e., finance charges and overhead. The Case Study II project made effective use of a modified fast-tract schedule. The activities were only partially overlapped for two reasons. The primary one was a requirement that eighty percent of the project be under contract before tax free bonds
could be sold. The second reason was to control the amount of risk to the client from proceeding without established permanent financing. Still, the facility was contracted in a number of packages in order to increase the competition; thus giving the construction manager better control over the total cost. Thus, the project managers were instrumental in integrating all activities of the process which are involved with money.

Still, the greatest effect that the project manager had was to integrate the project team under the leadership of a highly capable organization. This success was primarily based on the reputation of the firm as an effective professional organization.
SUMMARY

The provision of major health facilities requires a complex process. Involvement in this process is not part of the normal hospital owner's experience. Consequently it is difficult for the client to perform all of the functions which are required of them by the building process. Professional project management is designed to perform many of these functions. The increasing complexity of the building process has made project management a necessary element to the success of any major project.

This report has attempted to develop a general theory for the application of management to the building process. The major conclusion has been that building project management requires an approach which embraces all aspects of the process. Consequently, clarifying all the activities involved has become a primary element of the discussion. It is suggested that a project manager should deal systematically with each of the required activities. This requires a management approach that addresses the integration of all the components of the process.

One of the most important elements of the discussion has been the identification of the various activities required for the completion of a building project. This has been facilitated by the development of a descriptive model based on the interaction of basic resources. It is suggested that this model describes a hierarchical framework.
which is useful in performing all the management functions.

The management functions have been described as: planning, organization, control, and communications. Of these organization is shown to be the most important and it is suggested that the primary responsibility of the project manager is to carefully assign responsibility for each activity to specific members of the project team. It is also suggested that the choice of team members should be preceded by the development of a comprehensive project plan. The goals-objectives-response planning model can be used in conjunction with the building process model to facilitate the development of a project plan.

The building process model is based on the ideas that all elements of the building process can be described as interactions among the four basic resources: people, money, time, and technology, where technology comprises all physical elements of the building.

Systems theory has provided the theoretical background for the development of the model. Hence the process is structured within a hierarchical framework which describes the level of integration required by different groups of activities. The model is implemented by the use of a master project schedule and linear responsibility charts which are structured by the hierarchical framework described by the model. These charts describe the interaction of people, activities and time and become a major part of the project plan.
Two case studies which represent the practical application of project management provide the conclusion. This section clarifies the theoretical discussion of project management with an introduction to its practical application. It also introduces various project management tools, such as cost control and communications techniques. The case studies effectively support the premises that total project management enhances the success probability of a project. Hence, this thesis provides a general description of project management for building delivery, but it becomes simply an introduction to the detailed understanding which is necessary for managing the building process.
APPENDIX A

SCHEDULES FOR CASE STUDY PROJECTS

This appendix includes a graphic and narrative description of the activities involved in the case studies. The graphic technique which is used to illustrate the activity schedule is derived from network scheduling methodology. The process is broken up into activities and events for the purpose of describing the process in discrete identifiable units. An event has been established whenever a need for communication between activities occurs. The vertical dashed lines which connect events indicate communication activities. Events which are shown at the beginning of the schedule designate activities which have partially preceded the initial point of the study. The length of each activity line is meant to imply an approximation of the duration of that activity rather than an accurate representation of the duration. Hence the project schedule provides a generalized description of the relationship between activities as they relate to time.

The project schedule is supported by a list which describes the major events which are numbered on the project schedule. When used in conjunction with the list of activities and the linear responsibility chart, the project schedule provides a detailed description of activities and of who was involved in each activity.
### ACTIVITY SCHEDULE

**PROJECT ONE - PHASE ONE (ALL ACTIVITIES)**

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**LEGEND**

- Owner
- Architect
- Hospital Consultant
- Project Manager
- Communications
- Event
- Team Meeting
### PROJECT ONE/PHASE ONE (HOSPITAL CONSULTANT)

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**LEGEND**
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- Consultation
- Communications
- Event
- Team Meeting
ACTIVITY SCHEDULE

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   2b. Financing Acquisition
   3a. Fee Budget
   3b. Fee Contract
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   lb. Space Programming
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C. Technology-Money
   la. Budget
   lb. Estimate
   2. Payment

D. Time
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   2. Activity Schedule
   3. Technology Schedule
   4. Permit Schedule

E. Out of System
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   2. Area Cost Study
   3. Market Need Study
   4. Regulations Interaction
   5. Real Estate Activities
   6. Legal

LEGEND

Implementation
Consultation
Communications
Event
Team Meeting
ACTIVITY LIST PROJECT ONE – PHASE ONE

1. Hospital consultant (H.C.) selected.
2. Begin contract negotiations between H.C. and owner.
4. Begin legal work on contract.
5. Finish preliminary financial feasibility study.
6. Establish financing proposition.
7. Begin acquisition of long term financing.
8. Finish legal work on H.C. contract.
9. Establish preliminary facility budget and have information available for programming and design.
10. Sign H.C. contract.
15. Finish H.C. activity schedule.
17. Finish preliminary regulations check.
18. Introduce regulations information into functional programming.
20,21,22. Begin space programming, design, specifications simultaneously.
23. Architect selected.
24. Begin contract negotiations between architect and owner.
25. Begin scheduling activities for architect.
26. Begin legal work on architect's contract.
27. Finish first program.
28. Payment request by H.C.
29. Begin acquisition of short term financing for payment of H.C.
30. Finish legal work for architect's contract.
31. Sign contract for architectural services.
32. Begin adjustment of fee budget based on architect's contract.
33. Begin adjustment of cash flow projection based on architect's contract.
34. End adjustment cash flow projection.
35. End adjustment fee budget.
37. Architect enters schematic design activity.
38. Building code study by architect begun.
40. Finish preliminary building code study.
41. Finish first schematic design.
42. Begin re-programming.
43. Financing acquisition for initial payment to H.C. completed.
44. Payment made.
45. Payment recorded.
46. Land optioned.
47. Begin legal work for land purchase.
49. Finish accounting for payment to H.C.
50. Adjust cash flow projection based on land cost.
51. Finish second program.
52. Re-start schematic design.
53. Finish financing acquisition for land purchase.
54. Finish legal work for land acquisition.
55. Complete land acquisition.
56. Begin recording payment for land.
57. Finish recording payment for land.
58. Finish second schematic design.
59. Begin third program.
60. Finish third program.
61. Re-start schematic design.
62. Finish schematic design.
63. Request for payment by architect based on finished schematic design.
64. Begin acquisition short term financing for payment of architect.
65. Begin schematic design estimate.
66. Begin check of project feasibility.
67. Finish schematic design estimate.
68. Check estimate against project budget.
69. Introduce discrepancy between budget and estimate into study of project feasibility.
70. Begin selection of project manager (P.M.).
71. Project found unfeasible, placed on hold.
72. P.M. selected.
73. Contract negotiations begin between P.M. and owner.
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<td>D. Time</td>
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<td>4. Regulations Interaction</td>
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<tr>
<td>E. Out of System</td>
<td>5. Real Estate Activities</td>
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<td>6. Legal</td>
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**ACTIVITY SCHEDULE**

**PROJECT ONE PHASE TWO (ALL ACTIVITIES)**

**LEGEND**

- Owner
- Architect
- Hospital Consultant
- Project Manager
- Communications
- Event
- Team Meeting
ACTIVITY SCHEDULE

PROJECT ONE PHASE TWO (PROJECT MANAGER)

SUBSYSTEM

A. People-Money
   1a. Financial Feasibility
   1b. Cash Flow Accounting
   2a. Financing Proposition
   2b. Financing Acquisition
   3a. Fee Budget
   3b. Fee Contract
   3c. Fee Payment

B. People-Technology
   1a. Functional Programming
   1b. Space Programming
   2. Specifications
   3. Design
   4. Construction Documents
   5. Contracting
   6. Construction

C. Technology-Money
   1a. Budget
   1b. Estimate
   1c. Payment

D. Time
   1. Cash Flow
   2. Activity Schedule
   3. Technology Schedule
   4. Permit Schedule

E. Out of System
   1. Team Selection
   2. Area Cost Study
   3. Market Need Study
   4. Regulations Interaction
   5. Real Estate Activities
   6. Legal

LEGEND
   ---------------- Implementation
   --------- Consultation
   ----- Communications
   • Event
   ▲ Team Meeting
## ACTIVITY SCHEDULE

**PROJECT ONE PHASE TWO (ARCHITECT)**

### A. People-Money
1a. Financial Feasibility
1b. Cash Flow Accounting
2a. Financing Proposition
2b. Financing Acquisition
3a. Fee Budget
3b. Fee Contract
3c. Fee Payment

### B. People-Technology
1a. Functional Programming
1b. Space Programming
2. Specifications
3. Design
4. Construction Documents
5. Contracting
6. Construction

### C. Technology-Money
1a. Budget
1b. Estimate
1c. Payment

### D. Time
1. Cash Flow
2. Activity Schedule
3. Technology Schedule
4. Permit Schedule

### E. Out of System
1. Team Selection
2. Area Cost Study
3. Market Need Study
4. Regulations Interaction
5. Real Estate Activities
6. Legal

### LEGEND
- Implementation
- Consultation
- Communications
- Event
- Team Meeting
ACTIVITY LIST PROJECT ONE - PHASE TWO

1. Same as 73 above. (Contract negotiations begin between P.M. and owner.

2. Legal work begins on P.M. contract.

3. Finish legal work on P.M. contract.

5. Complete P.M. contract negotiations, contract signing.

6-21. Initial P.M. activities begin:


7. Evaluate financing proposition.

8. Begin P.M. input into financing acquisition.


10. Evaluate functional program.

11. Evaluate space program.

12. Evaluate outline specifications.

13. Evaluate schematic design.

14. Evaluate technology budget.

15. Re-estimate schematic design.

16. Evaluate cash flow schedule.

17. Evaluate activity schedule.

18. Begin area cost study.

19. Evaluate market need study.

20. Evaluate situation relating to restrictions and permits.

21. Evaluate real estate budget and acquisition.

23. Financial feasibility and cash flow adjusted along with financing proposition (24) technology budget (27) and schematic design estimate (28) information input into design and programming activities.

25,26. Functional and space programming complete.

29,30. Cash flow and activity schedules adjusted.

31. Begin technology acquisition schedule.

34. Real estate situation clarified, previously acquired property found to be suitable.

35. Initial area cost study complete.

36,37. Input from area cost study into technology estimate and budget.

39. Finish schematic design.
40. New request for payment by architect.

41. Begin acquiring interim financing to pay architect.

42. Technology acquisition schedule complete and information input into cash flow schedule (43).

44. Money available to pay architect (46) and accounting of payment (45).

47,48. New estimate and budget, based on area cost study, established and input into design process (50).

51. Cash flow schedule adjusted.

52. Begin working drawings.

53,54. Finish design development and outline specs.

55,56. Request for fee payment and begin payment procedures.

57. Check financial situation as it relates to architect's fee.

58. Begin scheduling for acquiring permits.

59. Acquire new information from area cost study and input into final estimate.

60,61. Finish paying architect for design development.

62. Finish construction documents.

63,64,68. Payment to architect for construction documents.

65,66. Estimate based on construction documents and budget check.

72. Check final estimate for financial feasibility.

70. Begin bidding.

71. Begin legal work on construction contract.

73. Finish writing contract.

75,81. Check financial feasibility based on lump sum bid also check budget (76) estimate (77) cash flow (78, 80).

79. Begin to clearly establish construction schedule.

74. Sign contract and begin construction.
ACTIVITY SCHEDULE

SUBSYSTEM

ACTIVITY

PROJECT TWO (HOSPITAL CONSULTANT/PROJECT MANAGER)

A. People-Money
   1a. Financial Feasibility
   1b. Cash Flow Accounting
   2a. Financing Proposition
   2b. Financing Acquisition
   3a. Fee Budget
   3b. Fee Contract
   3c. Fee Payment

B. People-Technology
   1a. Functional Programming
   1b. Space Programming
   2. Specifications
   3. Design
   4. Construction Documents
   5. Contracting
   6. Construction

C. Technology-Money
   1a. Budget
   1b. Estimate
   1c. Payment

D. Time
   1. Cash Flow
   2. Activity Schedule
   3. Technology Schedule
   4. Permit Schedule

E. Out of System
   1. Team Selection
   2. Area Cost Study
   3. Market Need Study
   4. Regulations Interaction
   5. Real Estate Activities
   6. Legal

LEGEND

- Implementation
- Consultation
- Communications
- Event
- Team Meeting
ACTIVITY SCHEDULE

PROJECT TWO (CONSTRUCTION MANAGER)

SUBSYSTEM ACTIVITY

A. People-Money
   1a. Financial Feasibility
   1b. Cash Flow Accounting
   2a. Financing Proposal
   2b. Financing Acquisition
   3a. Fee Budget
   3b. Fee Contract
   3c. Fee Payment

B. People-Technology
   1a. Functional Programming
   1b. Space Programming
   2. Specifications
   3. Design
   4. Construction Documents
   5. Contracting
   6. Construction

C. Technology-Money
   1a. Budget
   1b. Estimate
   1c. Payment

D. Time
   1. Cash Flow
   2. Activity Schedule
   3. Technology Schedule
   4. Permit Schedule

E. Out of System
   1. Team Selection
   2. Area Cost Study
   3. Market Need Study
   4. Regulations Interaction
   5. Real Estate Activities
   6. Legal

LEGEND

Implementation
Consultation
Communications
• Event
△ Team Meeting
ACTIVITY SCHEDULE

PROJECT TWO  ARCHITECT

SUBSYSTEM

ACTIVITY

A. People-Money
   la. Financial Feasibility
   lb. Cash Flow Accounting
   2a. Financing Proposition
   2b. Financing Acquisition
   3a. Fee Budget
   3b. Fee Contract
   3c. Fee Payment

B. People-Technology
   la. Functional Programming
   lb. Space Programming
   2. Specifications
   3. Design
   4. Construction Documents
   5. Contracting
   6. Construction

C. Technology-Money
   la. Budget
   lb. Estimate
   lc. Payment

D. Time
   1. Cash Flow
   2. Activity Schedule
   3. Technology Schedule
   4. Permit Schedule

E. Out of System
   1. Team Selection
   2. Area Cost Study
   3. Market Need Study
   4. Regulations Interaction
   5. Real Estate Activities
   6. Legal

LEGEND
- Implementation
- Consultation
- Communications
- Event
- Team Meeting
ACTIVITY LIST PROJECT TWO

1. Architect and Construction Manager contracts signed.
2. Contract fees, for A/E and C.M., input into cash flow projection.
3. Initial financing proposition completed and financing acquisition process begun.
4, 10. A/E and C.M. fees input into cash flow schedule.
5, 11. A/E and C.M. activity schedules established.
6. Begin code searches and interaction with regulating agencies.
7. Preliminary functional program complete.
8. Begin master planning.
12. Begin space program.
14. Finish "BLITZ" and adjust budget (15), input information into design, specifications and programming activities (16, 17, 18, 19) and adjust cash flow projections (20) and cash flow schedule (21).
22. Begin acquisition of real estate (option land).
23. Begin legal work for real estate transaction.
24. Begin acquiring interim financing for real estate purchase.
25. Check financial feasibility of real estate transaction.
27. Finish Master Plan.
28. Request for payment by architect and payment cycle begun: 29, begin acquiring financing, (32) acquire financing and pay, (34) also record payment (33).
30. Financial feasibility of land deal established and information input into financing acquisition activity (31).
35. Financing for land acquired, legal work completed (37) and land purchased (38).

36. Record made of purchase.

39. Initial program package complete.

40. Information from cost study prepared and "building model" estimate begun (41).

42. Begin acquisition of funds to pay monthly C.M. billing.

43. Acquire funds, pay C.M. (45) and record payment (44).

46. Finish "building model" estimate, adjust technology budget, also input information into design, specifications and programming activities (49, 50, 51, 52).

54, 55. Establish new program based on "building model" estimate and input into design activity (56).

57. Finish Master Zoning.

58. Begin Master Zoning Estimate with information from area cost study (59).

60. C.M. monthly payment, see 42.

61. Finish Master Zoning Estimate and adjust technology budget (63), cash flow schedule (62) and financial projections (65).

64. Input information from M.Z. estimate into design activity.

66, 67. Document space program and begin program estimate.

A. Project Team Meeting, discuss progress and present Master Zoning.

68. Finish program estimate and adjust budget (70) and cash flow (69, 72) also adjust program.

B. Project Team Meeting.

73. Begin acquisition of another parcel of land same cycle as above at 22, events 74, 75, 76, 79, 81, 82, 83, 84.

85. C.M. fee payment.

86, 87. Begin construction and permit acquisition schedules.

89. Finish Schematic Design.
90,93. Schematic Design Estimate.
91. Request for payment by architect.
92,95. Acquire money, pay fee (97) and record payment (96).
94. Adjust Schematic Design in relation to estimate.
C. Project Team Meeting to present schematic design and discuss progress.
98. Begin construction documents.
100. Begin preliminary negotiations with contractors.
101,102. Introduce contractors input into technology schedule and permit schedule.
103. Contractor selection begins.
D,E. Project Meetings.
104. Initial bid package completed.
105. Functional programming completed.
106. Space programming completed and input into design activity (107).
108. Bids delivered.
111,113. Bids checked against estimate and budget.
112,115. Legal work on first construction contract (site work).
114,117. Check financial feasibility of site work bids.
118. Finish negotiations and sign site work contract.
119. Begin site work.
120. Begin clarification of construction schedule.
121. Finish design development.
123,124, 128,129. Architect's fee payment for design development.
Check D.D. estimate against budget and cash flow projection.

F. Project Meeting to discuss Design Development.
APPENDIX B

Development Process - Gerald Hines Interests

I. PROJECT PROPOSAL

1. Establish Objectives
   Identify all possible given objectives

   Aesthetics - Establish form and materials
   Function - Establish required programs
   Schedule - Establish critical dates
   Budget - Establish Maximum Budget

2. Preliminary Pro Forma
   Develop operating Pro Forma

   Projected cost Pro Forma
   Income Pro Forma
   Expense Pro Forma

3. Advise Client on Selection of the Following:
   Consultants
   Architect
   Associate Architect
   Engineers
   Landscape Architect
   Interior and Graphic Designers
   Contractors
   Material and Systems Vendors

II. RESEARCH

1. Market Analysis

   Identify potential users
   Identify potential services programs
   Identify new markets that may be generated
   Define status of local building industry

2. Identify and evaluate potential risk

3. Site Study

   Evaluate existing Master Plan
   Evaluate proposed sites
   Advise on selection of a site
   Advise on acquisition of Real Estate
   Evaluate future land use
   -Proposed site
   -Adjacent properties
   -Long term impact

100
Identify Site Access and Circulation
Evaluate existing parking conditions
Evaluate existing transportation data
- Available public transportation
Coordinate survey for proposed site
Coordinate soil testing
Evaluate existing utilities
Evaluate climate conditions

4. Investigate Approval Process

Federal Authorities
State Authorities
- State Health Department
- Comprehensive Health Planning Agency
- Certificate of Need
Local Authorities
- Local Health Department
- Local Zoning and Code Restrictions
- Local Building Permits

III. FINANCING

1. Method of Financing

Determine the financial organization
Identify Risk versus Return
Based on relative positions of venture participants

2. Identify Funding Sources

Long Term
Short Term
Joint Venture
Total Equity

3. Advise on Available Financing

4. Financial Programs

Coordinate Mortgage and Interim financing
Develop Tax Plan
- Identify tax shelters
Contract outside participant to hold equity position
- Credit Lease
- Management Contract

5. Cash Flow

Determine Cash Flow requirements
- Month by month basis
IV. CONCEPTING

1. Develop Priorities for the Decision Making Process

   Outline anticipated problem areas in the planning and construction process
   Identify possible tasks that require decisions
   - Document critical data
   - Develop framework for decision making process

2. Develop Architectural and Engineering Concepts

3. Basic Program

   Evaluate basic program on client needs versus wants
   total area versus total budget
   Establish equipment requirements fixed medical equipment
   Coordinate existing equipment to be moved

4. Establish Building Standards

5. Evaluate Systems

   Elevator
   Vertical Movement
   Horizontal Movement
   Trash
   Linen
   Communication

6. Basic Design

   Evaluate Basic Design "or:
   - Building Quality
   - Program Response
   - Structural Systems Selection
   - M.E.P. Systems Selection
   - Finish and Material Selection
   - Operating Cost
   - Building Management

7. Cost Analysis

   Develop cost estimates on all phases of design and construction
   - Schematic Design
   - Design Development
   - Construction Documents
   - Bid
   - Construction
Develop cost estimates on alternative approaches and schemes
Develop cost estimates on systems
  - Comparative analysis
Develop cost estimates on tenant improvements
Develop cost estimates on fixed medical equipment
Restructure income and expense Pro Formas as the project concepts change

8. Coordinate Team

Coordinate the planning and construction team
  Client - Consultant - Architect - Engineers - Construction Manager
  - Schedule meeting
  - Identify critical due dates
  - Develop critical path as related to the total project

9. Review Plans and Specifications and advise Client and Architect thereon

10. Agency Approval

Coordinate agency approvals with all parties concerned
  - Federal
  - State
  - Local

V. CONSTRUCTION

1. Negotiate Contracts with the Following:

  General Contractor
  Prime Specialty Contractors
  Prime Suppliers
  Sub Contractors

2. Prepare and Administer Contracts

3. Provide Building Technology

  Methods of Construction
  Materials Technology

4. Scheduling

  Develop Construction Schedule
  Develop Individual Task Schedule
    - P.E.R.T. Chart
    - C.P.M. Chart
5. Receive, catalog, and distribute drawings, specifications, and shop drawings

6. Coordinate all changes to the original plans during the construction process

7. Coordinate pre-bidding of selected materials and labor

8. Coordinate mass purchasing program

   Elevators
   Doors
   Lights
   Hardware
   Carpet
   Toilet Fixtures

9. Provide Project Supervision

   Administration
   Project Inspection
   Progress Reports
   Expediting
   Cost Control

10. Administer Construction Approvals

11. Analyze and approve for payment all invoices and sub-contractors' applications for payment

12. Coordinate construction for Tenant Improvements

13. Coordinate Tenant Move-in

   Identify existing items to be moved
   Coordinate dates and methods of the move

VIL COMMUNICATIONS

1. Develop Communications Planning and Strategy

2. Establish a Communication Program related to:

   Community
   Medical Center Board
   Physicians

3. Develop a Promotional Brochure for Fund Raising

   Identify and document innovative concepts that have been established on the project
4. Develop a Publicity Program

Photos
Press Statements
Progress Reports
Special Events
Direct Mail
Media Advertising

VII. MARKETING

1. Develop Marketing Feasibility Studies and Appraisals for Lease Space
2. Evaluate Lease or Partnership Agreements
3. Create Standard Lease Forms
4. Coordinate Lease Space Design and Construction
5. Coordinate final Tenant Improvements and Move-in

VIII. PROPERTY MANAGEMENT

1. Coordinate Building Operations, Start Up and Testing
2. Provide Trained Personnel

Leasing
Building Management
Building Maintenance

3. Coordinate relationship with independent leasing agent
4. Screen prospective tenants for proper use of the facility
5. Develop standardization of the management operating programs
6. Establish methods of Cost Control related to:

Building Operations
Building Maintenance

7. Advise tenant on future improvements

Changes in Construction
Remodeling
Future Additions
APPENDIX C

Contents of C.M. Associates Project Manual

1. Construction Management Contract

2. Fee Summary Sheet

3. Accounting Sheet for C.M. Fee
   A. Management
      Executive
      Project Management - design
      Project Management - construction
   B. Production
      Estimating
      Scheduling
      Value Engineering
      Project Accounting
   C. Miscellaneous
   D. Profit and Overhead on Site Labor

4. Accounting Sheet for Reimbursable Expenses
   On Site Management
   On Site Office (Monthly Rate)
   Miscellaneous - Permits, Travel, Reproduction, Photography

5. Cash Flow for Fees

6. Project Goals Sheet
   A. General description of project including services, number of beds to be added (hospital), and what type of renovation, etc.
   B. Budget
   C. Description of expected product
   D. Alternatives
   E. Time restrictions

7. Outline Specification
   A. Performance Specifications
   B. Outline Specifications

8. Project Strategy
   Package bids and phased construction, etc.

9. Project Directory

10. Survey and Inspection

11. Licenses and Permits

12. Team Decisions
13. Submittals Procedure
14. Supplementary and Special Conditions Estimate
15. Bonds and Insurance
16. Contract Strategy
17. Bidders Register (In Contract Packages)
18. Change Order Procedure
19. Site Meetings (notes)
20. Weekly Reports
21. Monthly Reports
   A. Project Status
   B. Project Payment
   C. Revised Schedule
   D. Contract Management
22. Photographs (Site progress)
23. Project Budget
   A. Construction Cost
   B. Fees
   C. Owner's Direct Cost
24. Cost Survey
25. Early Start Cost Estimate
26. Schematic Design Estimate
27. Design Development Estimate
28. Fees and Reimbursables
29. Cash Flow - Estimate/Schedule
30. Contract Documents Estimate
31. Bid Evaluation
32. Project Cost Status Report
33. Payment Status Report
34. Cost Narrative Report
35. Design Schedule
36. Initial Master Schedule
37. Construction Schedule
38. Occupancy Schedule
REFERENCES

1  CM•Associates, CM Associates Brochure, Houston, Texas


5  Ibid.

6  Johnson, op. cit., p. VII.


9  Ibid.


13  Johnson, op. cit., p. 32


17  Tuite, op. cit.
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