September 27, 1974

A Study of Management Systems for

Department of Regional Economic Expansion

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A STUDY OF MANAGEMENT SYSTEMS

related to the acquisition of buildings and public facilities and the development of guidelines for the selection, application and monitoring of a management system

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for

DEPARTMENT OF REGIONAL ECONOMIC EXPANSION

Prepared by:

The Mansfield Consulting Group Ltd.
99 Yorkville Ave.
Toronto, Ont.

27 September, 1974

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The Mansfield Consulting Group Ltd.

Staff team:

(Hanscomb Roy Associates)

Brian Bowen
Henri-Paul Parenteau
Peter Emmings
John Dilworth
Steve Allen

(The Webb Zerafa Menkes Housden Partnership)

Peter Webb
Charles Benson
Forrest Grillson

27 September 1974

CONTENTS

1.0 INTRODUCTION

1.1 THE PROBLEM

In recent years a growing range of alternatives has been presented to program managers for the acquisition of facilities. Some of these alternatives have been devised and developed by program managers themselves. Others have been produced by various elements of the construction industry and marketed as integrated systems or put together in an ad hoc response to an immediate requirement.

It is probable that no more than 50% of the total Canadian construction expenditures of $23 billion (1974 estimate), is put in place using the sequential/linear method of carrying a project from inception to occupancy. This percentage level has gradually been reducing, as the industry and clients respond to increasing pressures to design and build faster, with better control over costs and with a greater likelihood of achieving a balanced value for money in terms of quality and performance. Of all these pressures, perhaps time has forced the greatest innovation. As the time available for facility acquisition compresses, then the decision making process must be accelerated, the information systems upon which this process depends must become more sophisticated and the requirements for good management must be far more evident. As a corollary, the penalties of bad management also become very obvious. In addition to speed, increasing facility size and complexity are other determining factors in producing new forces on project control. It is of general interest to note that the Empire State building was constructed in 1929 in 13 months, whereas the Sears tower in Chicago, now the tallest building in the world, has taken 29 months in construction.

All of these factors (speed, size and complexity) place increasing strains upon the traditional systems of facility acquisition and lead to much experimentation and innovation.

It is not the purpose of this report to analyze why these trends are taking place, although a recognition of the pressures behind the changes should provide some insight into the future and a better appreciation and understanding

of current practices. The wide acceptance and utilization of varied methods of facility acquisition touches all parts of the industry, and the public sector is no exception. Several public agencies and institutions have developed new procedures and are the subject of continual proposals from both organized bodies and individual firms within the industry. The Department of Regional Economic Expansion in its role of managing programs providing for the design and construction of projects identified in agreements between the Federal and Provincial governments, has been in a unique position to observe these developments. In doing so it has recognized two significant problems:

a) A wide variety of differing systems of project management are offered from the private sector, as recommended methods under which the acquisition process in whole or in part may be carried out.

b) Many officials in the field, both Federal and Provincial, responsible for advising on control methods for DREE projects, are unfamiliar with the terms and conditions under which these services are being offered.

Similar pressures exerted on the public agencies by other sectors of the industry and alternative methods to deal with such pressures, necessitate assistance in arriving at fundamentals and clarifying issues at stake.

In summary therefore, it was felt that a study was required to provide assistance in appraising new methods for facility acquisition, in analyzing proposals submitted from the private sector and in establishing criteria for selection purposes.

1.2 PROGRAM MANAGEMENT

Before proceeding to identify the objectives and scope of this study and the methodology employed for it, it is important to define the prime term used herein - "program management". Indeed, throughout this study an attempt will be made to clarify the bewildering array of terms, words and phrases which seem to attach themselves to the growth of any new technique. (Refer to Glossary, Appendix I.)

"Program management" is a broader term than "project management", with which it can readily be confused. Programs may be of the "capital P" variety, such as "a Program to increase the share of the gross national product contributed by the Maritime Provinces", or of the "small p" variety, which might be "a program to up-grade the primary and secondary educational facilities of the Province of New Brunswick". Whilst interesting possibilities concerning improvement in the management and control of the former type of Program exist, it is more with the latter type that this study is concerned. This form of program will embody a number of different projects involving the acquisition and improvement of facilities. A project is the actual end product of a construction process, which becomes a project only when a decision has been made to build. At this point in time, the project has to be managed and "project management" will start, terminating once the project is complete and in operation. Program management, on the other hand, is concerned with the events leading up to the decision to build, the formulation of management policies, standards and scope, and with the information generated after the project is completed, in addition to overall monitoring of the work as it proceeds. Thus, program management begins before an architect or engineer is commissioned and ends well after the general contractor's guarantee period has expired. Program management is therefore very much a series of functions best carried out by the facility sponsor, although elements of the management process involved may well be delegated to others in certain circumstances.

Within the context of this study, the noun "program" is taken to mean a plan of action which includes the assembly and analysis of data and project objectives to enable its translation into functional facility requirements, together with a budget, a schedule and an organizational structure for the conduct and control of the tasks in the project.

Based on this definition, program management could perhaps be better defined as being management by program, that is, managing by using the objectives and bench marks set out in the program as control and performance measurement criteria.

It is interesting to observe, that whilst private developers have devised fairly sophisticated methods of project management, they have been less concerned with managing a series of projects by program objectives, due to the simple fact that private industry tends to be project oriented rather than program oriented.

1.3 OBJECTIVES OF THE STUDY

The objectives of the study can be simply stated:

a) to undertake a study of management systems related to the acquisition of buildings and public facilities, and in particular to develop a body of knowledge concerning the nature and effectiveness of management systems;

b) to develop guidelines and a series of criteria and objectives for the selection, application and monitoring of management systems appropriate to facilities financed by the Department of Regional Economic Expansion;

c) to develop for operations officers a manual of guidelines which will assist them in selecting design effective facilities and which will provide check points by which the selected management system can be monitored and controlled during the acquisition process.

1.4 OUTPUT

The following output is a product of the study:

a) a report detailing the examination and review of management systems as they are currently practised within the construction industry, and

b) a program management manual in a prototype form for use by operations officers to assist in selecting appropriate management systems for specific facilities and to assist in the monitoring process.

1.5 SCOPE AND METHODOLOGY

Boundaries

One of the first tasks was to establish the boundaries of this study. After some consideration it was decided to begin at the first inception of the facility acquisition process, to proceed through the normal events necessary to convert this need from an idea to descriptive and graphic terms, thence to production information, procurement action, construction and commissioning and, finally, to occupation and operation. (See Figure 1.)

Significantly, the greatest difficulties in defining the boundaries were experienced at the outer limits, that is, at what point in the inception process should the examination begin, and how far into the facility operation should the study be taken.

Whilst the wider economic and program issues concerned with project inception must be of considerable interest, it was decided that the scope of this study should be restricted to a commencement from the point at which the basic need for a project, within a total program, has been established. Similarly, in order to establish manageable boundaries, it was decided to limit the scope of the study to cover immediate feedback after occupancy and operation only, rather than to examine issues related to a total occupancy monitoring approach over the complete life of the facility.

BOUNDARIES OF STUDY

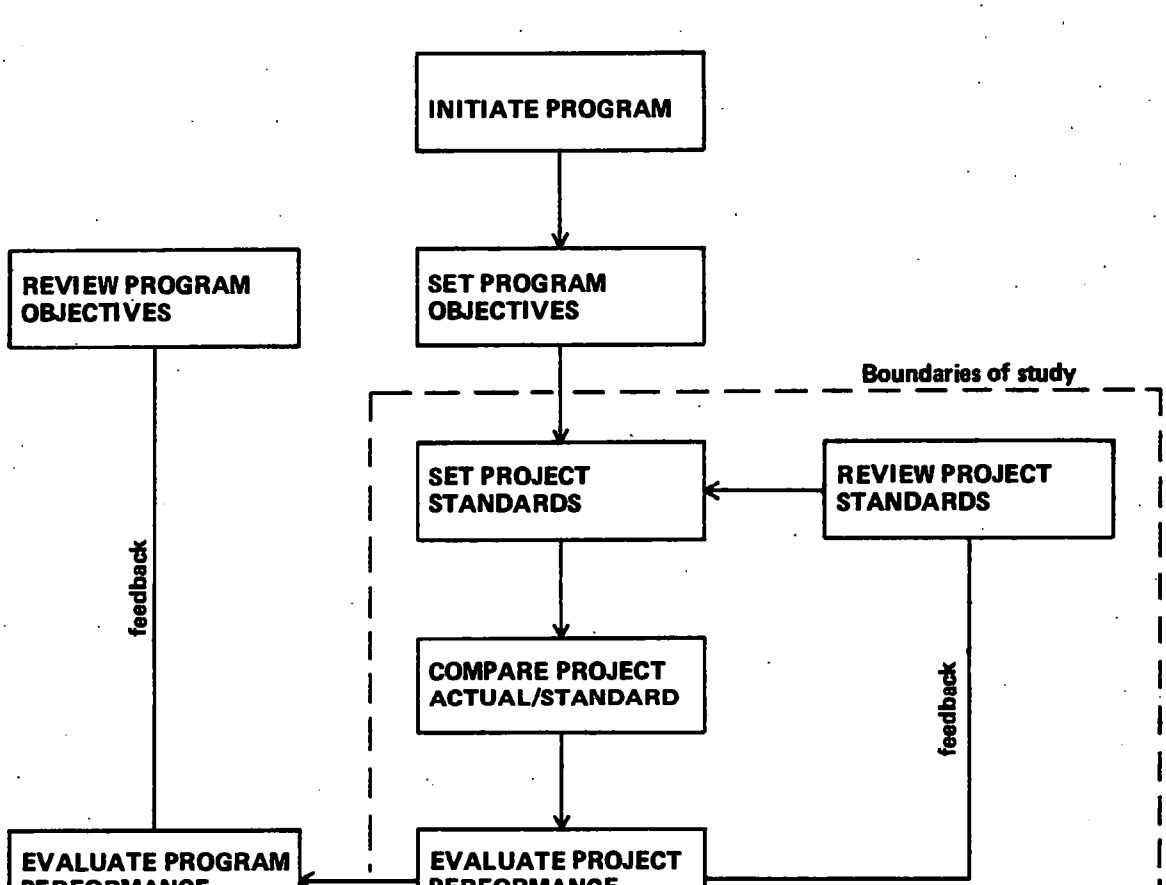


FIGURE 1

Methodology

The approach to the study was as follows:

a) a definition of the objectives, boundaries and scope of the study;

b) an examination of management in the abstract sense, its objectives and functions and organization into varying systems (Section 3.0);

c) an examination of the management systems currently being utilized in the construction industry. This portion of the study involved the development of case studies of actual construction projects, together with an extensive literature search in development of a suitable bibliography (Section 4.0);

d) an examination of program management in relation to the identified management systems and control elements (Section 5.0).

e) The findings of these examinations were then analyzed and the basic framework and objectives for the program management manual developed (Section 6.0).

Finally,

f) recommendations for testing and up-dating of the manual were produced (Section 7.0).

2.0 SUMMARY AND ABSTRACT OF REPORT

2.1 Some myths & realities . . .

It is not often that someone is given the opportunity to sit back and examine in some detail, and with some objectivity, what is happening in the complex area of construction industry management processes. The first thing to be realized, after a few days' study, reading and contemplation, is the wide prevalence of hallowed myths, obvious misconceptions and common misinterpretations. There is probably more nonsense written and spoken about management, and particularly about project management, than on any other subject pertinent to the construction industry.

This study has attempted to strip away some of the cobwebs and irrelevancies that have attached themselves to this subject, by trying to come to grips with essentials related to the scope of work as earlier defined.

First it should be stressed that project management is not a management system in its own right. It is a function which is only a part, albeit an important one, of a total program management process. Similar comments apply to the term "construction management" which is seen in its literal sense, as the management of the construction process only. Likewise, the method of financing a particular construction contract should not be confused with a system of management: for example, a lease-back arrangement is not an alternative management system to a sequential approach. Similarly, the form of construction or procurement contract utilized, whether cost plus or lump sum, has little bearing on the type of management system. All are, of course, important elements of management, but do not dictate the system.

Similarly, "buzz-words" like: fast-track, life-cycle analysis, total responsibility contract, guaranteed performance proposal, etc., while appealing, are often misleading. We have resisted, as far as possible, the

temptation in this report to "terrorize" the reader by terminology, into believing that aspects of management of construction are comprehensible only to the privileged few. We would hasten to add that whilst a clear understanding of the methods in use and options available is essential, this does not imply that those possessing such an understanding will automatically qualify as managers and coordinators of the design and construction process. As this report will testify, there are many other qualities required of the potentially successful manager, but certainly a clear understanding of the processes is a necessary prerequisite.

2.2 Abstract . . .

In Section 3.0 of the report, "Management" is examined. The job of management is seen as developing overall strategies for the future (planning), developing specific tactics related to the problem in hand and building an appropriate organization to handle it (organizing), formulating an overall control system (control), working with people to ensure that the objectives and standards are met (direction and coordination).

A management system as such is seen as a set of components, being these basic functions and their interrelationships, related to the established management objectives.

In the construction industry, certain peculiarities are immediately evident. The design and construction processes are separated under different jurisdictions, which has created special problems and has dictated in large measure the traditional approach to facility acquisition, where design was completed before construction began. Increasing attention is now paid to coordinating these two basic functions or overlapping them in some way. Because of their separation, there is an evident need for a coordinating function, whichever form of management organization is employed. The concept of program management responds to this need, by setting clear objectives, monitoring the process and evaluating results.

The study identifies three basic management systems in common use in the industry today:

a) Sequential/linear (SL)

b) Construction management (CM)

c) Turnkey (TK)

The systems are largely differentiated by the relationship between design and construction. In SL these functions are distinctly separate; in CM some overlap and feedback from the construction process occurs, and in TK the two are fully coordinated.

The report analyzes the advantages and disadvantages between each system, each of which may be appropriate according to client requirements and project circumstances.

Within each system, certain basic stages must be followed. These are:

- programming
- feasibility analysis
- design
- construction documentation
- tendering/negotiation
- construction
- delivery and operation planning.

Overlying these basic sequential stages, is a coordinating function which utilizes cost, time and quality control systems to ensure that facility delivery matches owner or sponsor requirements.

The industry is already well organized to respond to the varied demands placed upon it. The report finds the industry to be largely organized on a horizontal basis between:

- sponsor/client/users
- professions (design and related)
- contracting organizations (general and sub-trade)
- manufacturers and suppliers.

No totally vertically integrated organizations exist as they do in other industries, although some integration is not unknown.

Despite the growth of independent management organizations, it is unlikely that these will achieve total domination of the coordination and management role within the industry.

The selection of a suitable system and the resources necessary to operate it, are examined. Critical factors to be taken into account are:

- project size
- type of facility
- complexity
- location of project
- cost factors (cost limits, form of procurement, long-term owning costs)
- time factors (project delivery time)
- quality considerations

The interrelationship of these factors is obvious and a suitable weighting must be made by program managers according to project circumstances, before suitable selection of a management system can be made.

In Section 5.0, the concepts of program management, its functions and responsibilities are examined in some detail. The principal tasks of planning, monitoring and evaluation are considered, together with their interrelationship to the project structure and management system. Program management is clearly seen as a broader function than project management, which is conceived as a specific assignment for the procurement of a facility within stated cost, time and performance guidelines. These guidelines are established by program management, which is also concerned with identifying the initial need within socio-economic constraints, defining this need, briefing project management, monitoring and evaluating efficiency and the effectiveness of the facility in relation to initial objectives.

Project management therefore is seen mainly as a coordinating role governing the resource inputs, with the objective of ensuring that program management objectives are met at the project level.

Based on the roles of project management and program management, together with identification of broad management functions and management systems, a basic framework for the proposed program management manual becomes evident.

The manual is intended to be used as a guide for program management to monitor individual projects within a program, from inception to completion, under any jurisdiction. The manual, as developed, is seen as a prototype, subject to field testing and further development. It is seen also as a set of guidelines and not as a set of procedures. It is clearly recognized that each program, and each project within a program, is subject to so many influencing factors, that no one set of procedures can possibly accommodate.

The manual sets out steps required for:

a) the establishment of expectations in terms of quality, budget and schedule at the program level;

b) the comparison of actual performance with the planned progress of work during the development of the facility;

c) the production of feedback information on the performance of the facility and the performance of the organization that conducted the project.

The manual is organized in a modular form to permit its use for any one of the three basic management systems previously identified.

Finally, this report recommends a procedure for testing and updating the manual.

In the appendices is attached:

- a glossary of terminology used throughout this report;
- a bibliography of texts and articles considered relevant to the subject;
- six case studies which analyze in detail actual projects and provide considerable insight into each of the basic management system families;
- a description of major factors to be considered in the appraisal of legal relationships between various parties in each of the identified systems.

A prototype program management manual has been produced as part of this study and is available separately.

3.0 MANAGEMENT SYSTEMS

"Although managing is still a long, long way from being a science, analysis of successful practice and of research findings gives us a set of concepts that can add substantially to a man's managerial competence."

The Process of Management; Newman, Summer, Warren; Prentice Hall, 1967.

3.1 MANAGEMENT - A DEFINITION

As this report is primarily concerned with concepts of management, it would seem appropriate to examine these concepts in some detail in order to clarify the context in which this study has been undertaken. The term "management" can be viewed either as a concept or as an organization.

What is management?

Many dictionary definitions are concerned with the negative aspects of management: "control", "gain one's ends", "contrive", etc., presumably due to the bad "press" management has acquired over the centuries. In modern terms, and in this report's context, management can be viewed as the activity required to organize, plan, control and improve human endeavour.

Who is management?

Management includes all persons in any organization who are officially vested with authority and accountability for directing those who carry out the work. In other words, management includes equally both the Deputy Minister and the Foreman on the job site.

3.2 MANAGEMENT OBJECTIVES

The fundamental objectives of management are as follows:

a) to identify clearly the results desired, to interpret needs, forecast trends and visualize future problems;

b) to establish criteria and standards for measuring performance, to formulate plans, programs and budgets and to develop related management controls;

c) to build and maintain an organization of people to ensure that the desired results are achieved;

d) to analyze results on a continuous basis, to adjust the objectives and organization, to take remedial action and to look for improvement;

e) to motivate all those involved in the project or organization, to inspire confidence, maintain discipline and encourage understanding.

To state the above another way, the job of management is to develop overall strategies in the light of current and probable future conditions; to develop specific tactics related to the problem in hand and formulate an overall control system; to allocate and build an appropriate organization and to monitor progress and, above all, to work closely with people to ensure that the objectives and standards are met satisfactorily.

Major management problems tend to arise from simple causes, such as: lack of clear-cut objectives and policies, inadequate management controls, lack of significant criteria for measuring results, etc. Examination of management failures is often a good way of understanding the requirements of competent management.

3.3 MANAGEMENT FUNCTIONS

Stated simply, management can be better understood if its basic functions are analyzed. There are five of these which can be considered:

a) Planning
b) Organization
c) Direction
d) Coordination
e) Control

Examining briefly each of these functions in turn:

a) Planning

Planning bridges the gap between where we are now and where we want to be. Planning is foreseeing the desired objectives, anticipating problems and developing solutions. Realistic planning is based upon an accurate analysis and evaluation of past performance, the present situation, existing resources and future objectives. Impulsive reaction to events as they unfold is very often only a response to problems, and exhibits the weakness attributable to a lack of orderly planning.

b) Organization

Nothing can be achieved without an orderly organization with a sound structure. It has been stated that the majority of management consultant assignments result from the revelation of defects in structure. Many fail to understand that all organizational structures are dynamic, requiring modification to meet changing circumstances. Because of this, the ideal organization must be a flexible one, embodying the following principles:

i clear lines of authority, accountability and responsibility;

ii smooth continuity of work flow;

iii avoidance of overlaps and gaps in responsibility, thereby enhancing optimum performance of each functional group;

iv ease of coordination and communication;

v periodic performance appraisals of both people and organizational structure;

vi recognition that job satisfaction of every person in the organization should be an attainable goal.

c) Direction

No matter how good the organizational structure may be, firm and decisive direction from the top, whether this be from an individual, a board, or a committee, is an essential ingredient of sound management. Much has been written concerning the ingredients required for creative leadership. Much of it comes down to an ability to foresee problems, motivate people, clarify objectives and correct problems as they arise.

d) Coordination

Coordination aims at people working together and lack of coordination causes much waste of time, effort and money. The most effective influence upon coordination is the exercise of personal awareness, insight and leadership on the part of the chief executives of an organization. Effective coordination of the activities of all units of the organizational structure, toward the accomplishment of a common end result, depends on management directions.

e) Control

Management controls are applied in order to recognize important trends, to foresee problems before they become critical, to assist in establishing objectives, long-range plans and programs, and to monitor progress against the desired overall results. The control structure may vary from program to program and project to project, according to the basic criteria established. Controls will involve cost effectiveness measurement, implementation, schedules, quality standards and an evaluation of the effectiveness of the coordination and organizational structure.

3.4 MANAGEMENT SYSTEMS

In the context of this report, a system is a set of components with their mutual relationships. In the field of management a system must have a goal, expressed in terms of managerial objectives. The components of the management system are the functions which have just been examined and their relationships are the lines of communication and authority which are established. Essentially, a management system is the organization perceived with its built-in dynamic process going from the planning function, through implementation to the controlling function in order to reach the managerial objectives. (See Figure 2.)

The contribution made by the systems approach to the evolvement of more modern management organizations, should be recognized. Essentially, the systems approach achieves its potency by going back to fundamentals. It asks first "What are the real problems? What are the real objectives? What are we trying to achieve?" Once these objectives are identified, the method of achieving them is examined as a system in itself and fundamental relationships are established for achieving the identified managerial objectives. Thus, management systems must evolve in response to specific situations and mutate as circumstances change.

FIGURE 2

MANAGEMENT SYSTEMS PROCESS

KEY: ═══ = PROCESS

4.0 MANAGEMENT SYSTEMS AND THE FACILITY ACQUISITION PROCESS

"It was the study group conclusion that the significant consideration is not what system or contracting procedure was used, but how it is managed."

Construction Contracting Systems - A Report on the Systems Used by PBS and Other Organizations; General Services Administration, Washington, D.C., March 1970.

4.1 MANAGEMENT AND THE CONSTRUCTION INDUSTRY

There are certain peculiarities evident in the construction industry which inevitably influence the management structures and systems which have developed over the years, and peculiarities tend to inhibit opportunities for improvement and better efficiency. A fundamental problem in the industry is the separation of the design and production functions and the fragmentation of these amongst a myriad of separate organizations. Few organizations exist which are capable of delivering a complete product, in the sense that, say, General Motors is able to. Hence, while management of the various individual parts may be satisfactory, an "overlayed" management system to bring the whole process together into a complete delivery system, becomes necessary.

The majority of management problems tend to exist between the boundaries of functions and these problems are particularly acute where boundaries are not easily distinguishable. Recognizing the inherent disadvantages of having design and production under separate jurisdictions, the majority of today's responses to the need for improved management systems involve attempts to eliminate or bridge the boundaries between these two main functions. The systems approach has a distinct bias towards having an overall form of control for a project. Unfortunately this is not found very often in construction. Yet it can be shown, on organizational grounds, that in the majority of cases a form of overall project control in construction is really essential.

It is not the purpose of this report to examine why design and production are separate in the construction industry, or what factors would be necessary to ensure their complete coordination through the industrialization of construction to modern standards. The fact is that we must work with what we have and, to repeat, the need for overall project control is all the more essential while the separation of these two basic functions continues to exist.

The concept of program management responds to this need in the management process, that of continuity of management to attain increasingly longer-term objectives. These objectives of necessity become remote from day-to-day operations in the drafting room or on the site, as they must transcend the intermediate goals to be fulfilled on such individual assignments.

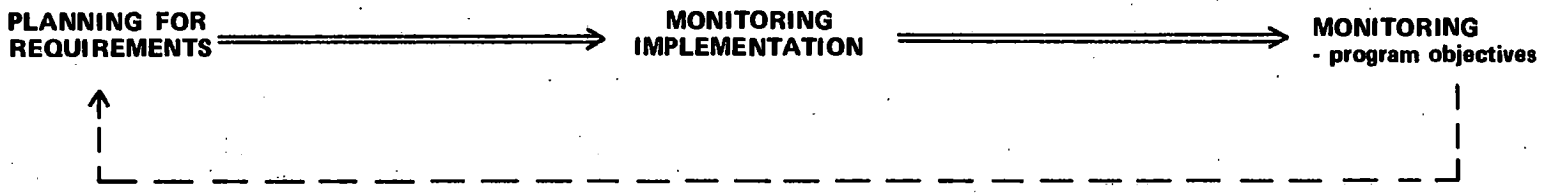
The program management system thus includes a new type of information flowing back directly from the controlling function to the planning function. Because the program management process involves the realization of implementation assignments, the basic process at the secondary level remains the same. The emphasis is however changed to planning for requirements, monitoring implementation and performance evaluation. (See Figure 3.)

If the organization of program management is considered as the system, sub-systems define themselves around individual assignments that are parts of the program. At this level of definition, the basic management functions remain the same, though the action requirements become more explicit. The assignment is now termed a project and the organization will fulfill the functions of design and production for that project.

As may be observed, there are many ways to carry out a project. Consequently there are different project management systems. We have broadly identified three basic types or families of systems which will be discussed in Section 4.2.

FIGURE 3

PROGRAM MANAGEMENT SYSTEMS PROCESS



KEY: ═══ = PROCESS
— — — — = COMMUNICATION

4.2 BASIC MANAGEMENT SYSTEMS

Faced with the problem of defining or categorizing the basic families of management systems in use in the construction industry for the acquisition of facilities, there is a temptation to be indiscriminate, due to the proliferation of terminology. However, once irrelevant issues (for the purposes of categorization) such as the form of financing, the type of construction contract employed, and the phasing of the work, together with confusing terminology, are set to one side, there are basically three types or families of management system:

- SEQUENTIAL/LINEAR (SL)
- CONSTRUCTION MANAGEMENT (CM)
- TURNKEY (TK)

In selecting titles for each of the families, the most descriptive phrase has been used. These may, unfortunately, be in some conflict with common usage, particularly for the second group - construction management - for which see later.

It should be noted that these three types of management system do not differ in their components, but rather in the relationships established between these components. In other words, the basic functions of management are retained and their respective activities will always be required, but the relationships of communication and authority will change as the system's objectives shift between mixtures of quality, cost, time and the required coordination of designs and construction activities.

a) SEQUENTIAL/LINEAR (SL)

Other terminology in use: traditional, traditional linear, conventional system.

The sequential/linear approach to facility acquisition has been the predominant method in use for many years, until recent experimentations with other methods became common. The method is still used extensively and still works very well when all circumstances are suitable. The system operates in a sequential manner, i.e. events take place consecutively. For example, buildings are completely designed before contracts are let for construction. The simultaneous occurrence of events is the exception rather than the rule. Basically, the sequential method involves the preparation of a program and design by a team of architects and/or engineers who may be employed as professional consultants, or may be part of the building owner's staff. Occasionally the definition of a program and the preparation of design become separate functions. On completion of design, competitive tenders are called and a general contractor is appointed to carry out the work, under the supervision of the design group.

A primary feature of the sequential method is the clear separation of the design and construction processes, and a secondary feature is the tendency for a linear consecutive approach for implementation to be taken. Opportunities are often taken to speed up the process by overlapping some of the design and construction activities, by appropriate phasing of the work, or by resorting to alternative contractual methods that do not depend upon prescriptive design (e.g. unit price bidding).

Figure 4 illustrates the basic SL management process.

PROJECT MANAGEMENT SYSTEMS PROCESS

SEQUENTIAL LINEAR SYSTEM

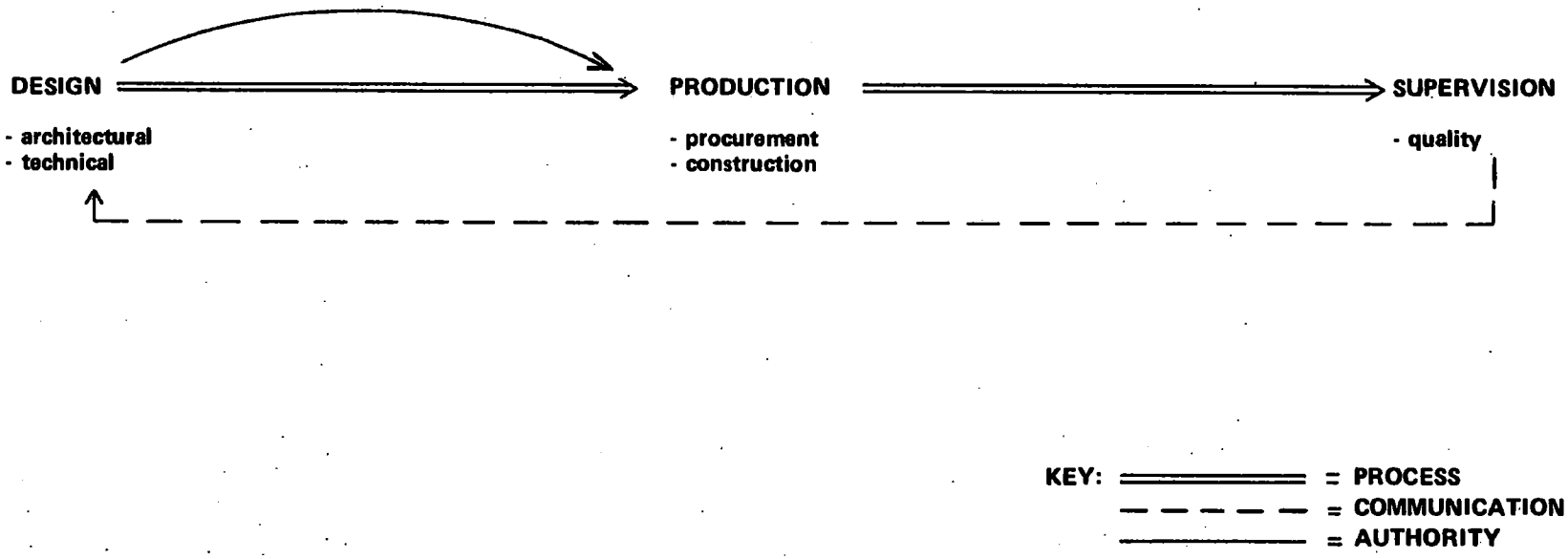


FIGURE 4

Problems with the system are:

i. A separation of the design and construction functions can often lead to uneconomic and impractical designs. There is a lack of feedback from the contracting/building organizations to the designing groups, due to their organizational separation.

ii. Because of the separation of these functions, it is necessary for elaborate legal and descriptive documentation to be produced, in order to protect all the parties concerned. It would probably be fair to say that many sequential/linear projects proceed under an air of suspicion and this readily leads to disputes, misinterpretations of intent, delays and other unnecessary events.

iii. The approach requires completion of adequate documentation before construction can commence and, thus, generally takes longer than any other system.

iv. Adequate cost control during design tends to be a hit and miss affair at the best, and cost control during construction often a series of claims and counter claims, change orders and rejection.

v. Opportunities to take advantage of technical and design innovations are often inhibited by the rigidity of the system and the difficulties of incorporating changes at any stage.

vi. As general contractors usually select their own sub-trades, the owner plays no part in this process. This is particularly the case with public agencies tied to open bidding procedures. They must also suffer unconditional acceptance of the "low bidder", except in extenuating circumstances.

Despite all of the problems and shortcomings, the sequential/linear approach is still in very common use and as such obviously embodies several advantages to the building owner.

Advantages are:

i. The owner retains reasonable control over the quality of the product by commissioning the design direct and specifying his exact requirements as it proceeds.

ii. When this phase is completed, he is presented with a firm price for the product and, assuming that few changes are made to the scope of work, can reasonably establish his final cost at this stage, before starting the work.

iii. The system provides for adequate competition in soliciting prices (except for design work), which is particularly important where public accountability must be satisfied.

iv. The owner is able to transfer a large proportion of his risk to the general contractor and to the designer and thus is protected against disaster. That he pays for this transfer of risk is axiomatic, but in a competitive market the price paid is generally marginal.

v. Management of the project is shared between the architect/engineer and general contractor, with the consequence that few management demands are placed upon the owner.

CASE STUDY No. 4 illustrates in detail the workings of a fairly typical sequential/linear project.

Variations to the system

Several variations to the basic system are commonly practised, usually with the idea of accelerating the process:

- overlapping of design and construction activities by phasing of the work (sometimes referred to as "fast-tracking");
- soliciting tenders on incomplete designs with the provision of cash allowances for undesigned portions (e.g. mechanical and electrical work) subject to tender at later stages;
- the utilization of cost-plus contract arrangements rather than stipulated sum, to accelerate the start of construction;
- the introduction of specialist cost and time control consultants to improve control of these elements.

b) CONSTRUCTION MANAGEMENT (CM)

Other terminology used: fast-track, project construction management (sic), parallel tendering.

The second family of management systems covers a broad spectrum of organizational structures which are difficult to classify under any one appropriate heading. The phrase "construction management" has been chosen as it is a term widely used in the industry and is, we believe, a more appropriate description than "project management", which has wider connotations as discussed later in this report. That the terms "construction management" and "project management" are often used synonymously, is indicative of the confusion which exists in the industry and of the indiscriminate use of terminology without appropriate definition.

Strictly speaking, the term construction management indicates simply the management of the construction process. However, the phrase has been chosen to describe this group of organizational systems which addresses itself to the problem of coordinating the design and construction efforts and should be construed as such throughout this report.

As has been previously stated, none of the basic functional and organizational needs is dispensed with or added to in any of the management systems discussed herein, but they are merely reorganized. The construction management group of systems varies only from sequential/linear by the introduction of a construction manager, at some point in the design process, usually at the commencement of detail design. The construction manager may be either a general contracting company, a professional firm or an individual; in each case construction management is

properly supplied in a professional manner. Thus, in many cases construction managers who assume many of the roles of a general contractor on behalf of an owner will do none of the actual construction work themselves, to avoid conflicts of interest. Occasionally construction managers are hired at the very outset of projects and may even be responsible for coordinating and developing the facility program. On other occasions construction managers may be appointed only once detail drawings are completed, merely replacing general contractors.

In addition to coordinating design and construction, the construction manager's duties will include cost control, scheduling, expediting, procurement, supervision and coordination of construction. The construction manager will generally procure tenders on behalf of the owner and develop contract packages according to the work in hand. He usually provides his own on-site personnel and often arranges for his own forces to supply temporary facilities.

Figure 5 illustrates the basic CM process.

Problems with the system may be:

i. Final costs are not known until construction is well under way.

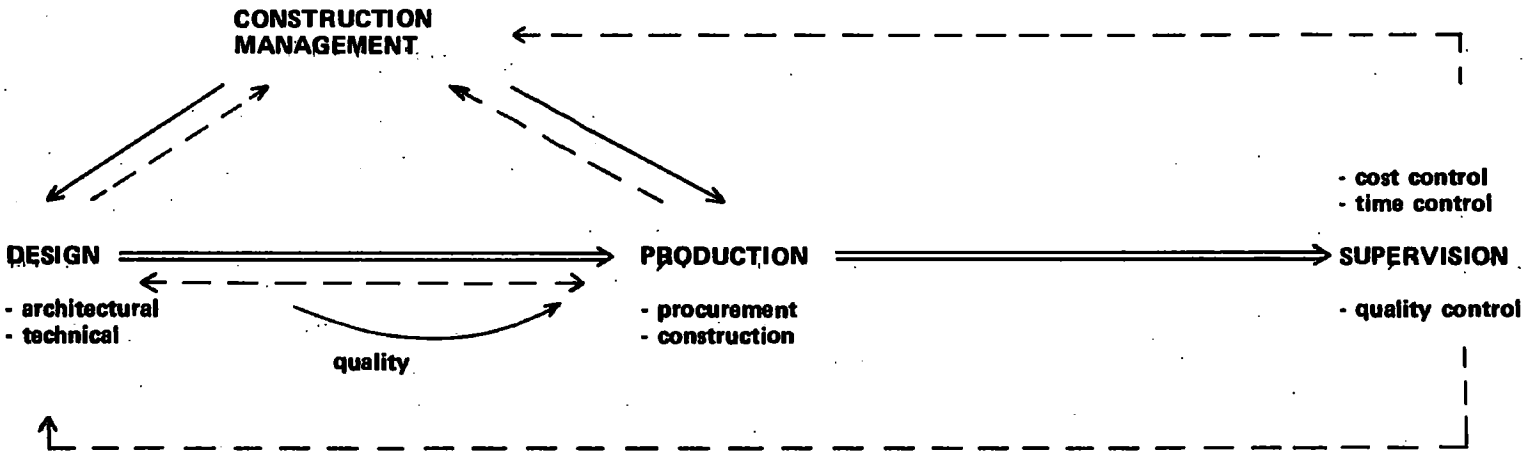
ii. Where construction managers are general contracting organizations, conflicts of interest may arise if they carry out any of the work directly and if they are dealing with the same sub-contractors they employ on their lump-sum work.

iii. Construction managers who are general contractors tend to emphasize solutions of construction problems, whereas construction managers who are professionals, emphasize design.

FIGURE 5

PROJECT MANAGEMENT SYSTEMS PROCESS

CONSTRUCTION MANAGEMENT



KEY: = PROCESS
= COMMUNICATIONS
= AUTHORITY

iv. Tensions often develop between the construction manager and the design group, particularly where responsibilities are not clearly defined.

Advantages are:

i. Construction expertise is introduced as designs are being developed.

ii. Generally an early start to construction can be expected.

iii. Cost and time control tend to be improved.

iv. Due to the overlap of design and construction and the delay of commitment (both in terms of design and contract), opportunities exist to respond rapidly to market conditions or technological improvements.

v. The system allows owners to be more selective in their control of who will undertake the work.

CASE STUDIES Nos. 2, 5 and 6 illustrate three alternative approaches, using the CM method:

No. 2 - Professional CM - where a professional firm of cost and time consultants was appointed as construction manager;

No. 5 - Conventional CM - where a contracting organization was retained as construction manager, with the owner retaining program management control;

No. 6 - Design-build CM - where the owner commissioned a conceptual design and then turned this over to a construction manager (general contractor) for completion of design and construction.

Variations to the system

The case studies illustrate a few. As the construction manager acts as a kind of bridge between SL and TK methods, the range of variations is as wide as the gap between the two. Thus at one end of the scale, design can proceed as in the SL system and a construction manager can be brought in only at design completion stage, to act more or less in the role of a cost-plus contractor. Alternatively, as in case study No. 6, a construction manager can virtually accept a design-build arrangement by taking over design responsibility once a concept is prepared. Occasionally, other consultants are brought in to take over cost and/or time control responsibilities, leaving the construction manager to concentrate on coordination and construction.

c) TURNKEY (TK)

Other terminology in use: design-build, developer proposals

Turnkey provides an organizational structure which is the complete opposite of the SL approach, insofar as TK totally coordinates the design and construction effort through one organization. In this organization, the design and construction personnel are generally employed side by side. On occasions, temporary or semi-permanent joint ventures may be formed between separate design and construction organizations, in response to a specific requirement.

The Turnkey contractor will invariably bid on performance specifications and a program provided to him by the prospective owner. These may be prepared for the latter by a consultant. The detailed design and layout is left to the contractor, who may bid in competition or negotiate.

Figure 6 illustrates the basic process.

It is not unusual for the TK contractor to provide land and finance, in addition.

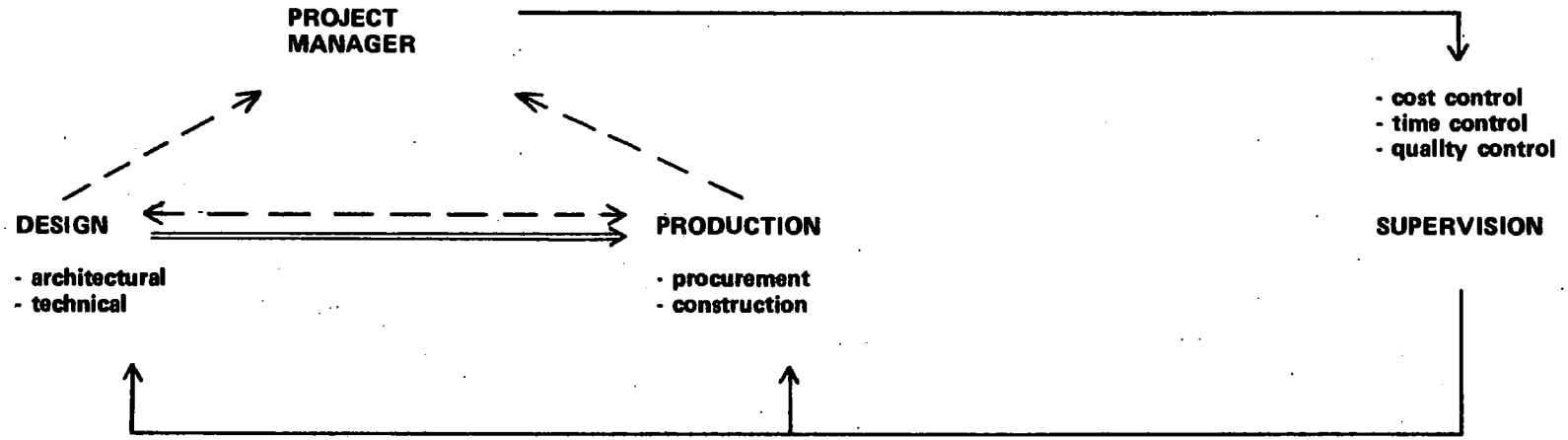
Problems with the system are:

i. Considerable difficulty exists in specifying adequately the exact needs of the owner, and the translation of these by the TK contractor into a project often leaves something to be desired. There is a natural tendency for the contractor to deliver the minimum quality and this is only encouraged if the owner's documentation is inadequate or ambiguous.

FIGURE 6

PROJECT MANAGEMENT SYSTEMS PROCESS

TURNKEY



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ii. It is not easy to accommodate changes to the scope or quality of the work.

iii. It is often difficult to fairly compare competing proposals.

Advantages are:

i. Design and construction are fully coordinated by one organization.

ii. Facilities are generally delivered more rapidly.

iii. A firm price is established at the outset.

CASE STUDIES Nos. 1 and 3 illustrate two TK projects, one for a commercial client and one for a federal government commission.

Variations to the system

Variations generally relate to how proposals are called and the conditions imposed. Thus, some owners may require that financing be provided, separate architects/engineers retained, two-stage proposals considered, etc.

4.3 FACILITY ACQUISITION STAGES & CONTROL SYSTEMS

Whichever basic management system is followed in the facility acquisition process, certain standard stages must be followed. These are reasonably obvious but can be listed in sequential order as:

- programming
- feasibility analysis
- design
- construction documentation
- tendering/negotiation
- construction
- delivery-operation planning

Programming represents the definition of the need and its translation into quantitative and qualitative requirements.

Feasibility analysis produces broad estimates of resources requirements.

Design translates program into a solution concept showing graphically the spatial and material requirements of the facility.

Construction documentation elaborates design into a form suitable for accurate costing of the facility and for the arranging of construction.

Tendering/negotiation is undertaken to obtain a price for the construction.

Construction builds and completes in accordance with project design and procurement requirements.

Delivery-operation planning prepares for the utilization of the facility.

Ultimately, occupation of the facility takes place which, it must not be forgotten, is the whole purpose of the exercise.

It is essential, as discussed in Section 3.0, that the organizational units responsible for their individual effort in each stage should manage in keeping with the best management concepts. In addition, however, several over-riding, coordinating control systems become a necessity in the bringing together of the above stages into facility realization. These are:

- control of scope
- control of cost
- control of time
- control of quality.

Control of scope

Fundamental to the whole facility acquisition process, is the ability of a sponsor/owner to adequately specify his scope requirements. These requirements must be monitored through the design and construction process to ensure they are being delivered and that early expectations are being met.

Control of cost

The objectives of a cost control system are likely to vary from project to project but will probably include the following:

- to maintain expenditures within an agreed budget;
- to ensure that the facility delivers good value for money.

In order to achieve these objectives the following principles are required:

a) realistic cost estimates from the outset;

b) sensible framework within which the costs may be controlled from inception to completion;

c) a method of checking and feedback to ensure that costs are being monitored as the project proceeds through design to construction and completion;

d) provisions for the taking of remedial action on the basis of the feedback reports.

These principles therefore dictate a continuous cost control activity from inception to completion. At early stages costs must be estimated; at later stages they are being reported as they are incurred and expended. Thus different techniques and skills are required, over the course of a project, to ensure that the control system operates adequately.

Control of time

As with costs, so the objectives of time control are similar:

- to ensure that the facility is delivered within the time specified;

- to ensure that it is carried out utilizing available resources to the optimum.

In order to achieve these objectives, the following procedures should be followed:

a) the establishment of master and detailed schedules, identifying the main target dates necessary for completion;

b) a monitoring system reporting actual progress against plans;

c) a mechanism for the taking of remedial action on the basis of the monitoring reports.

The scheduling techniques which will be used will vary according to the size, scope and complexity of the project in hand. For simple projects this may involve a simple bar chart, and for more complicated work the use of network planning (e.g. CPM, PERT), operated manually or by computer may be necessary.

The interrelationship of cost and time control is obvious. A number of techniques provide for coordinated reporting of time and cost status on projects.

Control of quality

The quality control program should ensure:

- that the overall quality is commensurate with budget limitations and time requirements;
- that a balanced quality level is achieved between all parts of the facility.

In order to achieve these objectives it is necessary to specify clearly quality and performance levels required and to coordinate these with the cost control function, to ensure that the budget adequately reflects requirements, or, where budget limits are paramount, that quality levels are suitably adjusted. In addition, an adequate inspection process will be necessary to ensure that the quality required is firstly specified and then delivered through the construction process.

The interrelationship between quality standards and long term owning costs should be considered where this may be of concern, through the use of life-cycle costing techniques.

4.4 ORGANIZATIONAL UNITS

If this report were an abstract study of the facility acquisition process, then the next logical step would be to devise the kinds of organizational units required to fit into the management systems identified and to undertake the main functions discussed. As the study is related to the construction industry as it now exists, it is necessary to be more practical and to recognize that the industry maintains a broad organizational structure which has evolved over a long period of time and which changes but slowly.

Without attempting an exhaustive analysis of the organizational structure of the construction industry, it would seem appropriate to identify the main organizational units in broad groups, certainly as far as they affect the main theme of this report.

Broadly, the industry can be sub-divided into four categories:

a) Sponsor/client/users

b) Professions (design and related)

c) Contracting organizations

d) Manufacturers and suppliers.

Certain miscellaneous organizations, such as regulatory authorities, labour unions, teaching establishments, etc. have been omitted for the purpose of this analysis.

Each of the four classifications can be further broadly sub-divided as follows:

a) <u>Sponsor/client/users</u>

Governmental (federal, provincial, municipal)

Institutional (school boards, hospital boards, universities, etc.)

Private (corporate building departments, private individuals, etc.)

Developers (real estate companies, speculative developers, etc.).

b) Professions

Architects and Architect/Engineers

Engineers (civil, municipal, structural, mechanical and electrical, etc.)

Urban Planners

Land Surveyors

Testing and Inspection Consultants

Management Consultants (project and construction management)

Quantity Surveyors and Cost Consultants

Scheduling Consultants

(Related professions serving the industry include: Lawyers, Accountants, Appraisers).

c) Contracting organizations

General Contractors (usually specializing: civil, residential, general building, marine works, etc.)

Sub-contractors (from electrical and ventilation to caulking and cement finishing).

d) Manufacturers and suppliers

Manufacturers of construction products and components

Suppliers of construction products and components.

While a horizontal separation of each group from another generally subsists in the industry, it is not unusual for some vertical integration to take place, although it seems to be the exception rather than the rule. Examples relevant to the theme of this study are:

- the turnkey firm which combines design professions and a contracting organization;
- a governmental sponsor/client organization that employs its own design professions;
- a real-estate developer who incorporates a contracting organization;
- a general contractor who offers professional construction management services, in addition to contract work;
- a manufacturer who also owns a sub-contracting organization for the installation of his products.

Total vertical integration is rare, but an objective that is being sought in some experiments with industrialized building processes.

Certainly the existing structure provides for a great deal of flexibility, being able to respond to a wide variety of demands and fluctuations in business activity. The fragmentation inherent in the structure does however place considerable pressure on the coordinating and control functions of overall program or project management. These functions are not clearly being assumed by any one of the organizational groups as a specific role. Despite the growth of separate firms to provide such services, it seems unlikely that they will come to dominate the field, when the possibility of the function being carried out by the client's staff, the design professions or the contracting group, is still accepted as a reasonable option.

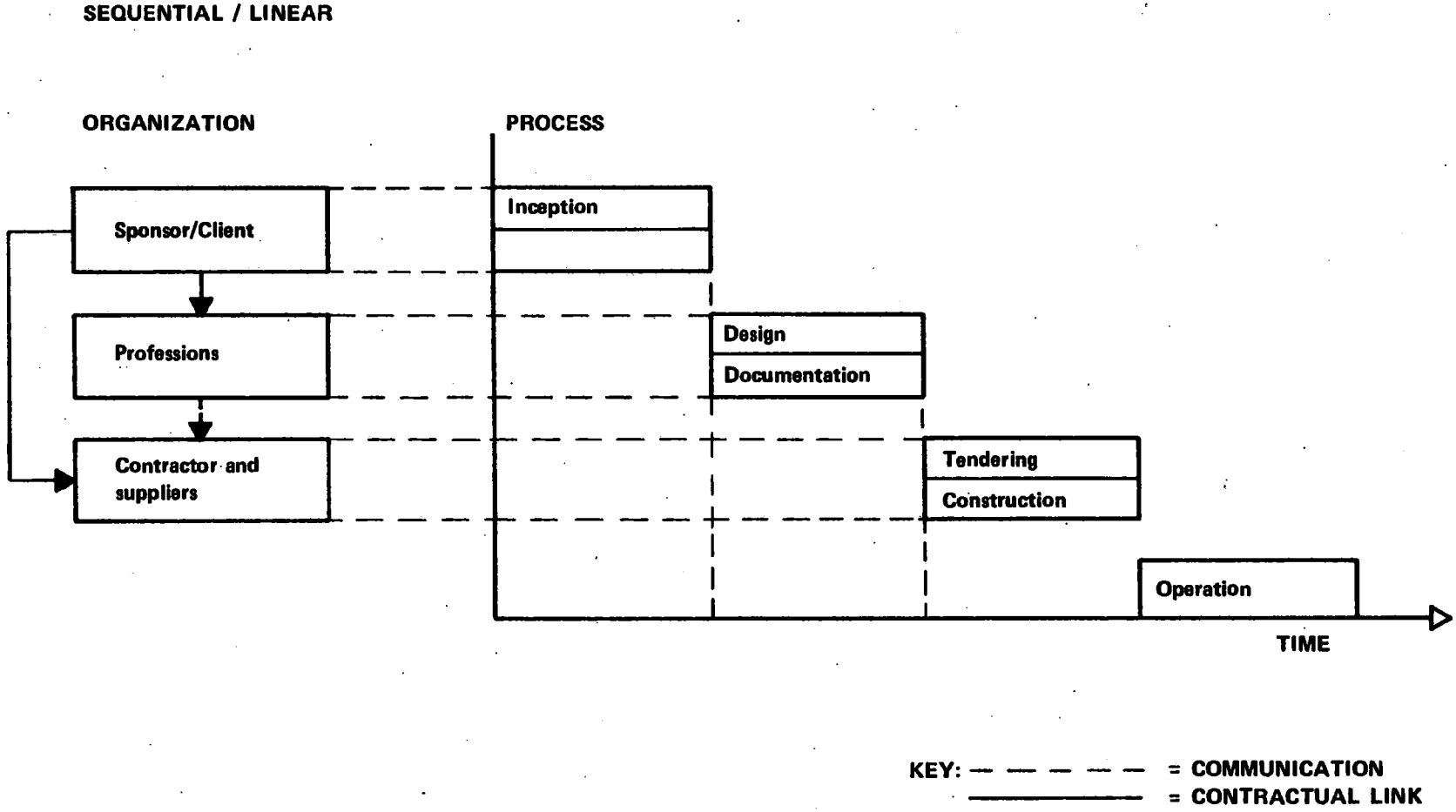
Legal considerations

The provision of adequate definition of the legal responsibilities between each of the groups involved, is a complicated but necessary task. Appendix III lists some of the major considerations concerned.

In Figures 7, 8 and 9 the respective roles of each group is illustrated, with their contribution to the development process and their mutual relationships in the three different management systems identified in this report.

FIGURE 7

MANAGEMENT ORGANIZATIONS IN FACILITY ACQUISITION



MANAGEMENT ORGANIZATIONS IN FACILITY ACQUISITION

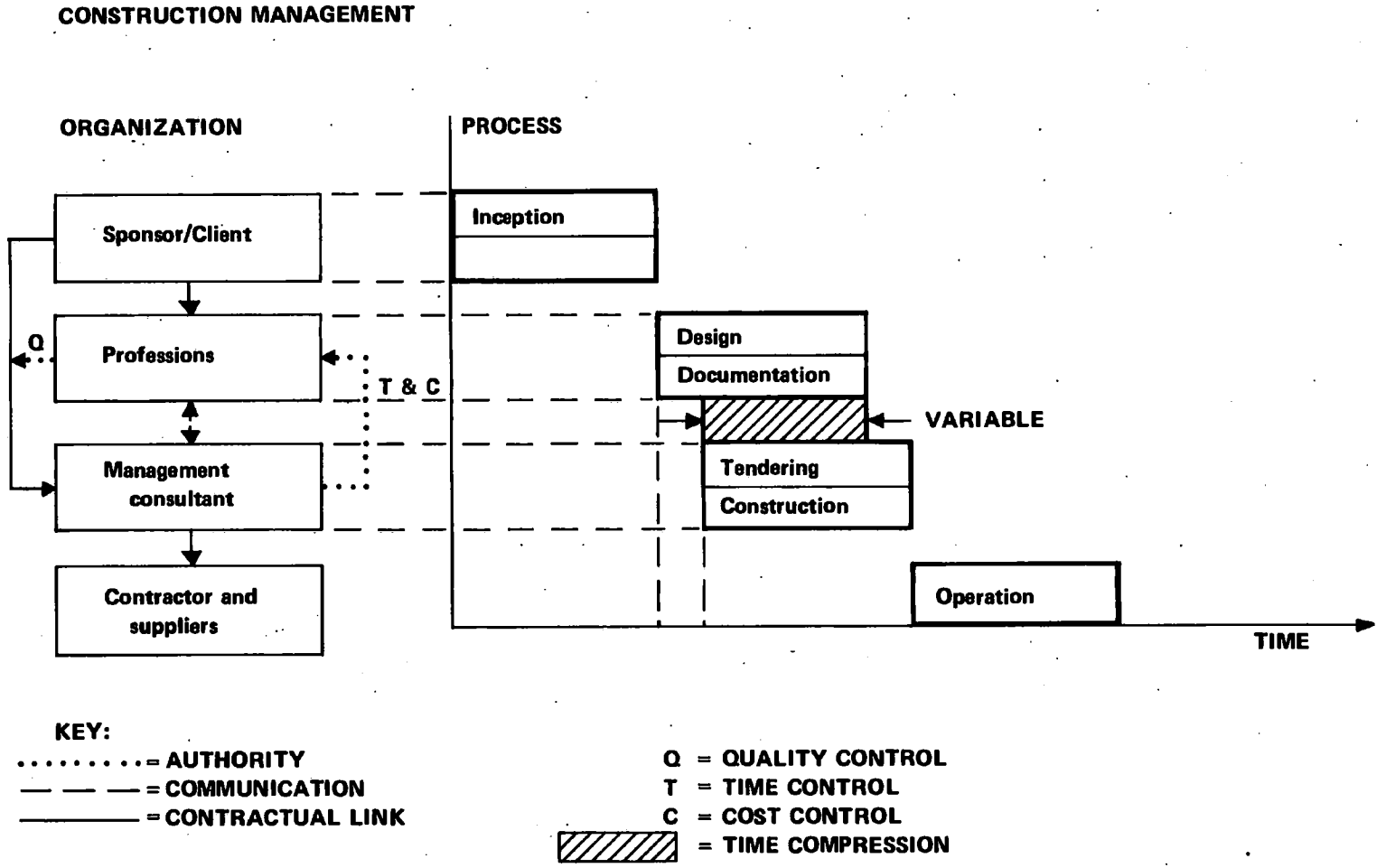


FIGURE 8

MANAGEMENT ORGANIZATIONS IN FACILITY ACQUISITION

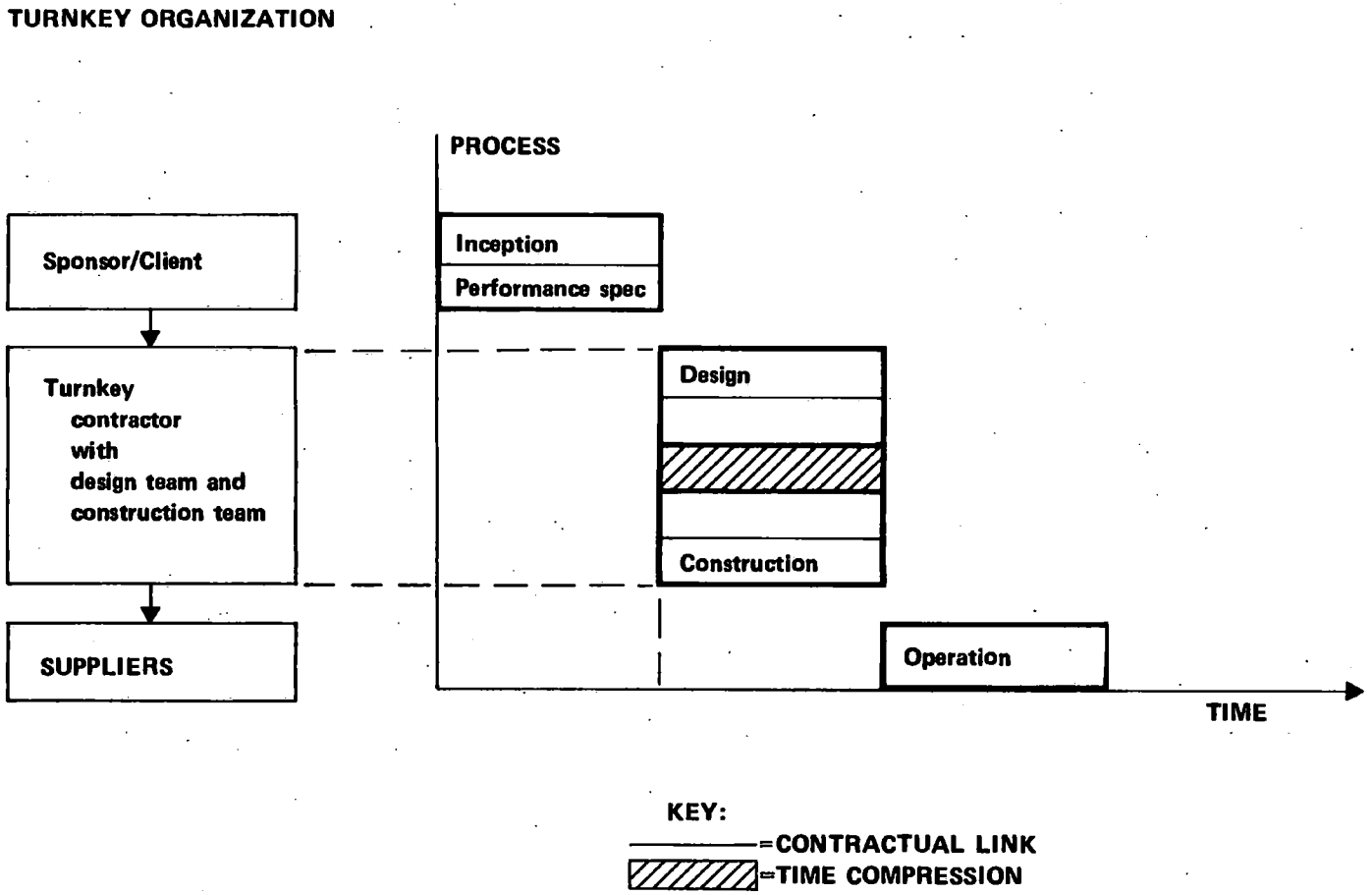


FIGURE 9

4.5 CRITERIA FOR SELECTION OF RESOURCES AND MANAGEMENT SYSTEMS

Program managers will be responsible for selecting the appropriate resources required and a suitable management system for the fulfilment of their program objectives and the delivery of facilities. Selection may be carried out in an environment of a multitude of options, or it may be severely restricted by the circumstances surrounding the program. Occasionally the selection process takes on the form of an evaluation, when program managers are required to appraise proposals placed before them.

Whatever the circumstances under which the selection/appraisal process is conducted, it is vital that a comprehensive and coherent set of criteria is used in making judgments and measuring suitability. Whilst, it is probable that each program will contain a unique set of criteria responding to the conditions surrounding it, it would still seem reasonable to assume that a standard set of criteria would form a useful base for the evaluation process. Critical factors to be identified are then as follows:

a) Scope

i. Facility scope

How large is the facility in terms of probable dollar commitment and quantities of the basic components (e.g. floor space, length of road)?

Large facilities and small facilities quite obviously create differing sets of circumstances, as far as resource selection and management systems are concerned.

ii. Type of facility

What type of facility is being considered? Will it contain any specialized areas or functions? What activity or process will be conducted in the facility when completed?

iii. Complexity

Is the facility relatively simple or will it require the application of specialized technical skills in its development?

iv. Location

Where is the facility to be located, or what criteria will dictate its location?

Facility location may well tend to influence the resources that are available to a program manager for design and implementation of the project.

b) Cost

i. How critical will project cost be?

Will it be of more, the same, or less concern than time or quality considerations?

ii. Will any restrictions apply on procurement methods?

Will public tendering and competitive selection of all resource elements be a necessity, or will there be some flexibility in this regard?

iii. Are concerns over first cost paramount, or are serious considerations to be given to optimizing total owning or life costs?

c) Time

i. Is time of the essence? Is it a more important consideration than cost or quality objectives?

ii. What will be the effect of failure to meet required occupancy dates? What cost penalties may be involved?

d) Quality

What are the quality and performance requirements of the facility? How important are these in relation to time and cost factors?

It is not unusual for a number of these criteria to be in competition with one another. Often unrealistic project objectives are established at the outset, from which a project never recovers. Achieving a balanced set of criteria is essential to permit rational selection of the best resources available and the most appropriate management system for implementation. No selection process yet devised is able, or should be able, to automatically select the best mix and formula. Thus the application of considered opinion and balanced value judgment on the part of the program manager is still a most essential ingredient in this process.

The selection and evaluation process is developed further in the Program Management Manual which accompanies this report.

5.0 PROGRAM MANAGEMENT

"In NASA we have found that we must be able to speak and understand the language of those on whom we rely, to know as much about the problems they are dealing with as they do, to check and supplement their work ..., to step in when required with the necessary specialists, and, in some cases, help untangle snarled situations."

James Webb, address at Harvard University, September 30, 1968 in Managing Large Systems, Leonard R. Sayles, Margaret K. Chandler; Harper & Row, 1971.

5.1 GENERAL

The program management concept was developed as a dynamic systems approach to the procurement of large-scale military and civil facilities. Complex programs can involve a number of organizations, from both the public and private sectors, that must collaborate in order to fully exploit technological and managerial skills required in the control of budget and time resources, and in the delivery of acceptable facility performance. The program management system thus includes a centralized mechanism whose primary responsibility is to provide overall coordination of the contributions of the diverse organizations involved. Coordination becomes a matter of putting into proper perspective the key factors of cost, time and quality. Coordination implies establishing means of communication between the participants to ensure compatibility of effort towards the achievement of a common task.

The organizations participant to a program's development can be numerous and varied, depending on the size and the complexity of the facility contemplated. At least, five logical participants are involved:

a) the sponsor, who devotes some resources to the development of the facility;

b) the user, who requires the facility for a given purpose;

c) the designer, who provides expertise for translating user requirements into a feasible, economic plan;

d) the contractor, who will physically produce the facility;

e) the manufacturers and suppliers, who provide the materials and components required.

Combinations of any two or of all five participants are possible in a single organization. Alternatively any one participant might actually represent many different organizations. For instance, a complex program can require many different contracting and sub-contracting organizations. Also, participant organizations may often come from the private sector, and a private contractor may, for example, be retained by a user from a provincial institution and a sponsor from a federal agency.

The program development process must necessarily go through a sequence of stages to fully accomplish its purpose. These are the facility acquisition stages, initiated by the expression of objectives, and terminated by performance evaluation:

a) perception of a need and resource allocation;

b) establishment of a technical program;

c) viability analysis of the program;

d) design, procurement and construction of the facility;

e) operation of the facility;

f) evaluation and feedback.

The initial phase is usually conducted prior to the instalment of the program management system; the fact that a sponsoring organization has recognized a need and agrees to allocate limited resources for its fulfilment, will lead to the selection of a suitable program management system for carrying out the project within resource constraints.

Thus, program management begins with an assignment that pursues a goal aimed at the fulfilment of a need and which is subject to constraints of limited resources such as budget, time and performance requirements. The management functions of planning, implementing and controlling will provide the framework within which the development stages will take place. Since some of the stages will be partially or completely carried out by contributing organizations, the sponsor organization will have to delegate much of the actual development work. However, effective program sponsorship will monitor the progress of the development work and support continuously the individual effort with team assistance or a special task force when necessary.

In the development of a facility, the Program managerial framework of Planning-Implementing-Evaluating, determines the organization of the developmental stages for more effective monitoring.

Program Planning is concerned primarily with the translation of a need into a technical program for implementation. Before implementation begins, planning must ascertain the technical and financial feasibility of the program, and would be well advised to ensure in addition, the longer term functional viability of the proposed facility. In program planning, the sponsor and

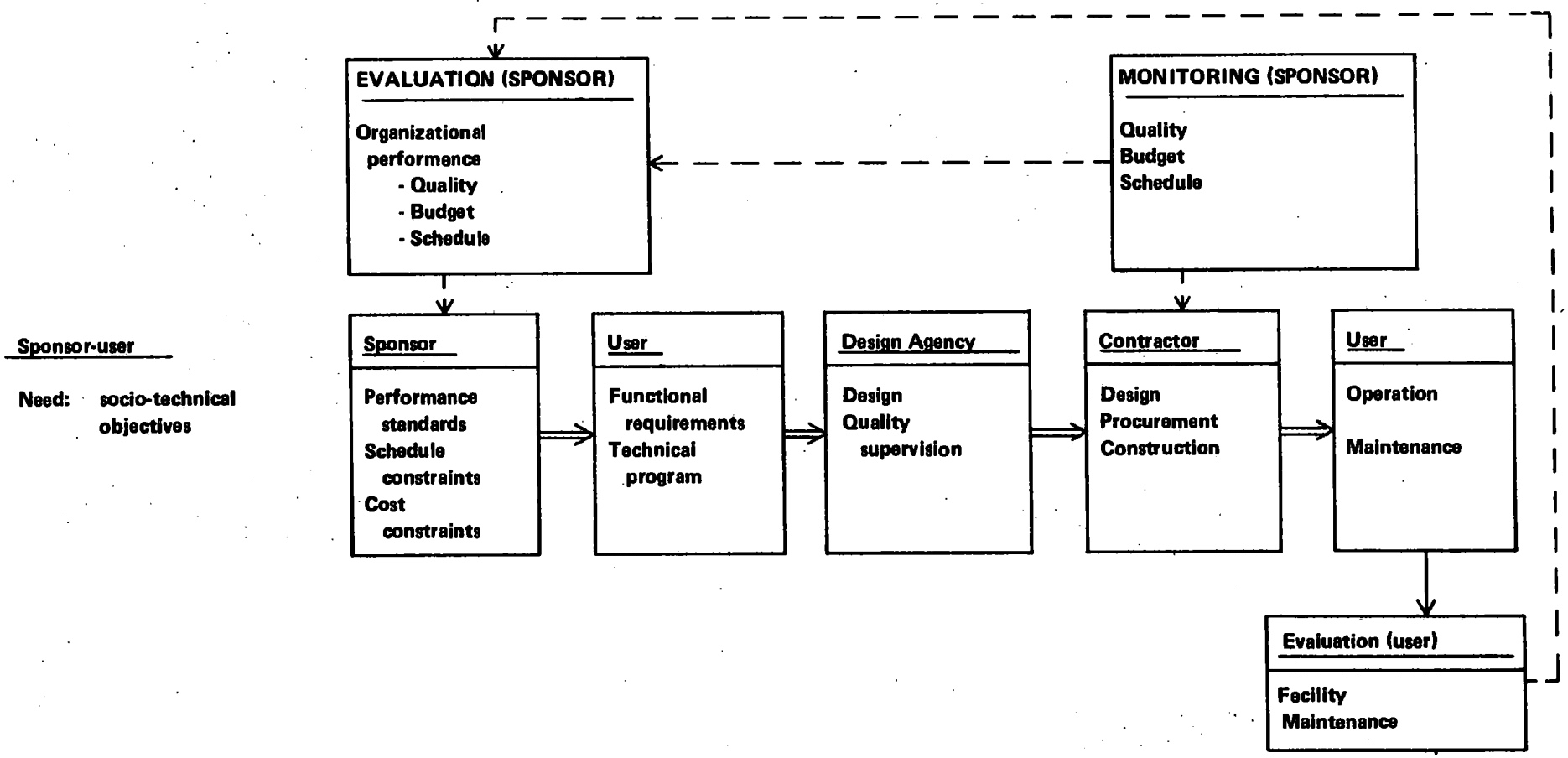
user organizations must be fully involved; the contractor may also contribute when technical assistance is desirable. The program manager has the responsibility to assign individual tasks to the best qualified organization, allowing for possible redirection of the effort as planning advances. He must, however, also ensure through the maintenance of extensive communication and support between the diverse organizations who may be concerned with the different aspects of the program that progress of the work remains within resources constraints.

Program Implementation will be carried out primarily by contractor(s) under the Project Coordinator, during the actual development of the facility. However, when the user or the sponsor specifies strict quality and functional performance, either or both can elect to guide the contractor with a design and supervision team of their choice. This is most frequently the case in the construction industry where the user will assign his own design team to the project to ensure the best functional performance; the sponsor, for his part, will monitor the design and construction to be ready to provide support should the development encounter difficulties.

Program Evaluation of Performance is a function specific to the sponsor organization. It is involved from first inception through to operation and is concerned with the evaluation of the performance of the facility and of the team which was responsible for delivering the facility. This evaluation will provide a measure of the effectiveness of the management system, and its feedback information can serve as guidance for future projects. Figure No. 10 shows how the development stages are inserted in the managerial framework, with each participant's respective role.

ROLES – RELATIONSHIPS

SPONSOR – USER – CONTRACTOR – DESIGN AGENCY WORK FLOW



Sponsor-user

Need: socio-technical objectives

FIGURE 10

5.2 PROGRAM PLANNING PROCESS

Conceptual planning initiates the management process. Planning involves a projection into the future to identify a number of specific activities that will lead to the attainment of a goal. In a socio-economic environment, it focuses on the utilization of scarce resources to produce goods or services essential to the goal pursued. The nature of these resources is manifold. In the development of physical facilities, materials and components are basic resources; manpower, energy and technical knowledge are necessary to transform and assemble the raw resources; finance is a resource which determines the value of the future product; and organization is a managerial resource that will permit control over the use of all the other required resources during implementation of development. Planning is essentially a projection of the allocation of all these resources.

Generally, the sequential managerial process of planning-implementation-control has proven to be an efficient, orderly approach to operational management. The sequence is rational: plans are devised quantitively on the expected output of an operating system the efficiency of which is controlled through historical performance records. In a project situation, however, the manager and his organization deal with a one-time undertaking. Project planning becomes possible when the manager possessing sufficient knowledge of the resource environment is able to simulate the planning of a forthcoming facility from his past experience. For instance, project planning techniques such as the CPM and the Bar Chart imply a reasonable assumption about future activities and the material, technical, financial and organizational resources required for the implementation of a project. This assumption is implicit to the planning activity, leading to a technical definition of the facility, followed by implementation and control.

As far as planning is considered, a program situation differs from a project situation in two ways. First, many

different projects are possible within a program because the socio-economic environment will determine locally how a perceived need will be fulfilled. For instance, a need for an educational facility in a rural, underdeveloped and distant area can be fulfilled quite differently from the same need in a metropolitan area. Second, in a program situation, for a prospective project, there is no a priori organizational setting. Rather, program management will be concerned with the selection of the project organization that will most adequately suit the local resource environment. The incentive to arrive at the best selection will be the overall constraints of budget, time and performance requirements.

a) Project Inception

Program management begins when a sponsoring organization has recognized a need and decides to fulfil this need through provision of the necessary facilities. The sponsoring organization can be a single institution, or a group of institutions representing interests at diverse levels, but sharing the common goal of fulfilling the need.

The sponsor group may or may not involve the user at this point. Involvement of the user however is desirable, in the sense that it creates a commonality of interests.

During the early stages of a common initiative, it is essential that each participant be in an exchange position vis a vis all other participants, in order to bring to bear fully his potential contribution. It is therefore ill-advised, at this point, to delineate the respective functions of the participants, thereby restricting any one of them to a formal role or a fixed pattern relationship to the others.

Considering an implementation strategy that requires the development of a facility, the initial work of the planning process is the translation of the need agreed upon into a technical definition of a project. Three basic steps can be identified, although their sequence might not be that distinct.

i. The first step is the expression of socio-economic constraints within which the program is subscribed. Because of the uncertainties at this stage of the program, these constraints can only be expressed as broad overall limits on budget availability, delivery schedule, and functional performance of the facility.

ii. The next step is the analysis of the functional requirements for the facility to meet its purpose. The major contribution at this step will be expected from the organization that is closest to the need and has the responsibility to ensure that this need is fulfilled in conformity with the user's objectives. The direct responsibility is usually given to the user. However, the sponsor, who might have developed a deeper perspective in the course of multiple prior projects, must be permitted to comment and support the analysis. By definition programming means common goals and converging interests.

iii. The third step follows the analysis of the functional requirements as they are formulated into a technical program describing spatial, environmental and quality requirements. This activity must be undertaken looking both forward at the organization that will be in charge of managing the forthcoming project, and backward at the people who produced the functional analysis. This technical program is a quantitative description of the project requirements, and thereby becomes the first check against the program socio-economic constraints of budget, time and facility performance. It is also a quantitative

estimate of the qualitative functional requirements. Thus changes must be expected as the user improves or modifies his expectations as to the utilization of the facility. This step must therefore be supervised by the functional analysts in the user organization in order to retain as much flexibility as possible for change and improvement. However, the output should be reviewed by a joint sponsor-user committee before implementation.

The three steps have been described sequentially but their actual conduct will tend to be an oscillating process where overlaps and re-evaluation will necessarily take place. Effective management will ensure that the overall process is moving forward within a reasonable schedule. This process is illustrated in Figure 11.

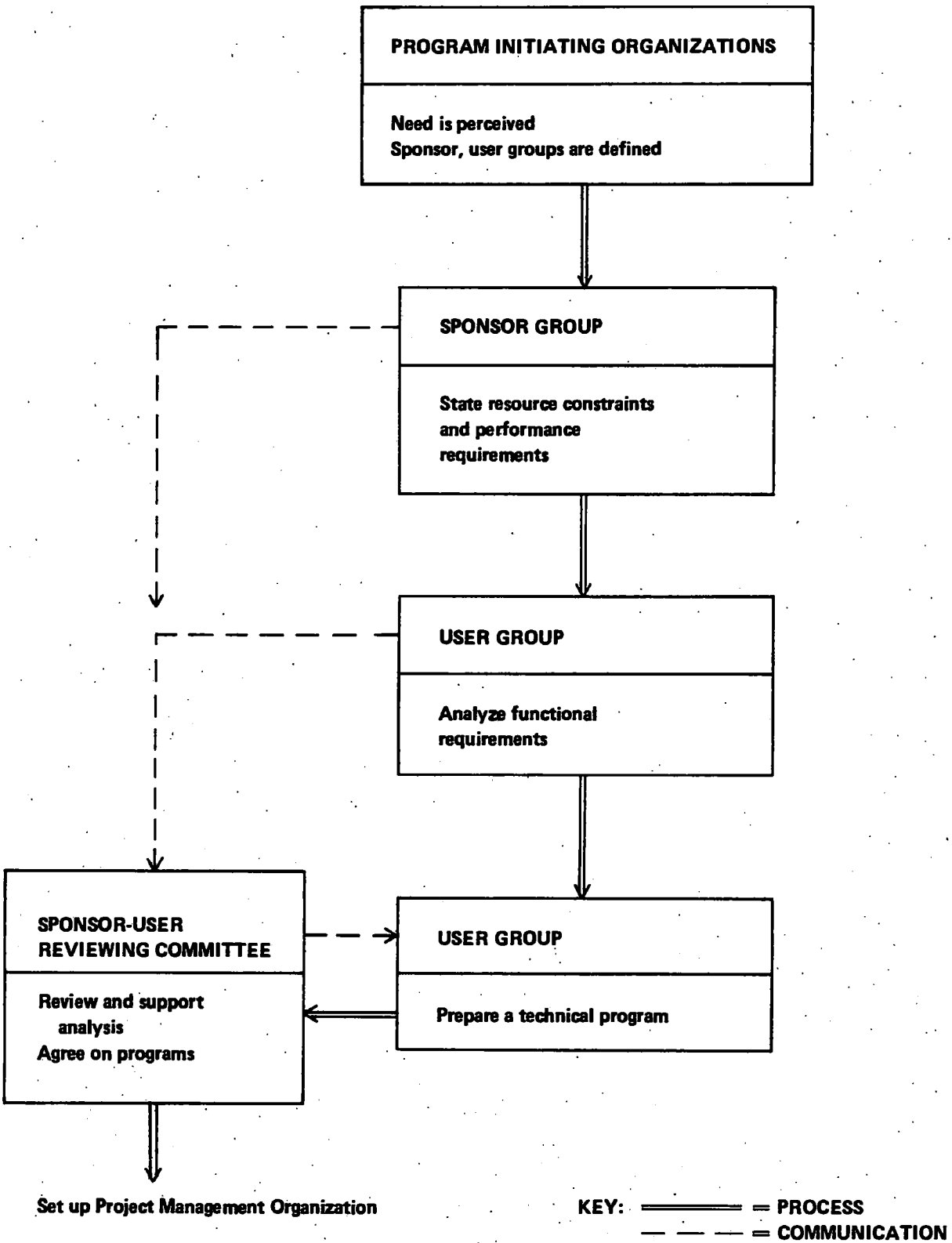

PROGRAM INITIATING ORGANIZATIONS
Need is perceived
Sponsor, user groups are defined
SPONSOR GROUP
State resource constraints and performance requirements
USER GROUP
Analyze functional requirements
SPONSOR-USER REVIEWING COMMITTEE
Review and support analysis
Agree on programs
USER GROUP
Prepare a technical program
Set up Project Management Organization
KEY: = PROCESS
= COMMUNICATION

FIGURE 11

b) Project Viability Analysis

The project viability analysis is conducted in two phases. The first phase concerns program management which must set up a capable project management organization. The second phase looks into the feasibility of the project.

i. Project Management Organization

The selection of the project management organization follows from considerations as to the program objectives of quality, time and budget, the features of the facility to be procured, the availability of regional resources and the type of organization that gives the best indications of meeting these objectives. The decision should properly belong to the project manager. This selection is judgmental, as no definite decisional pattern can apply to every particular situation. Nevertheless, a procedure of evaluating possible organization types based on previous project records can provide useful guidelines. Program management, if properly conducted, can assist in that direction because it is involved in many projects. A decision process, based on a rational approach, developing from general conditions to more and more specific features of a single project and its environmental conditions, can be experimented with in the course of a program. Even though it might not be readily accepted fully by project managers, it can help in providing them with a framework for reaching a better decision, or at least inducing them to consider deeply this major step of program management.

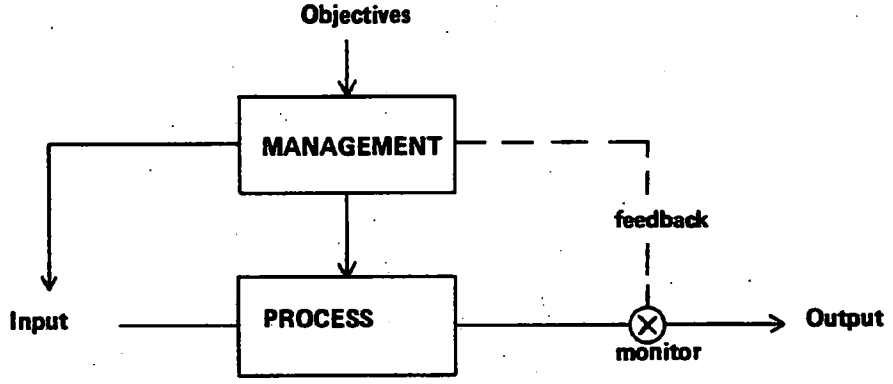
ii. Project Feasibility Analysis

The second phase of project viability analysis is project feasibility. The project manager must conduct this analysis with the assistance of the project team he has established. After eliciting all information obtained from the technical program, he initiates the work of the team members. Studies should be carried out to determine the site characteristics, such as soil conditions, lot limits and drainage, general access, public services, any existing buildings, etc. Transportation facilities, environmental factors and other amenities must also be surveyed before project viability can be assessed. The design consultants, referring to this survey, will produce an architectural or engineering program that takes into consideration the user requirements and the new technical data provided.

The architectural or engineering program is a conceptual design showing the general configuration of the facility, indicating the overall circulation axis and the major space allocation and uses. This program will also contain a master cost and time schedule. The final master schedule must be consistent with program constraints as it will serve as the operational plan of project management. Program management should provide support in the course of the feasibility analysis, supplying feedback information from prior experiences. As agreement on the feasibility of the project is reached by all parties, program management must state clearly that it will monitor implementation and evaluate the organizational performance on the basis of this agreed program.

5.3 PROGRAM MONITORING

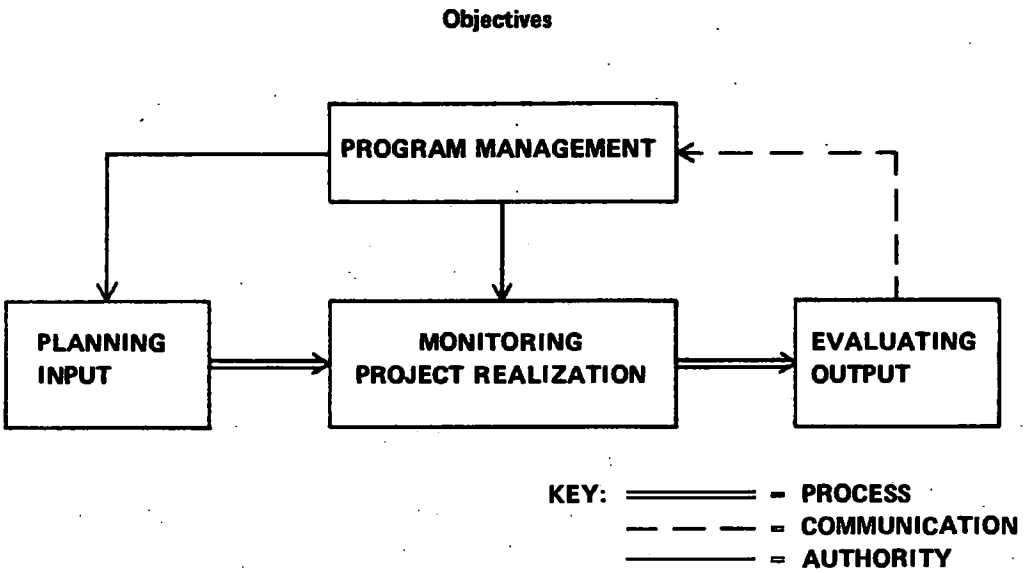
Monitoring is an essential function of management to ensure that plans are carried out within organizational objectives. The monitor, in a production process, is a continuous control device that makes measurements on a product, compares actual readings with expected targets and produces a signal to indicate conformance, or non-conformance, to the stated specifications. In serial production, monitoring is exercised at the output of a system. For instance, physical attributes of a product are tested as it comes out of the process; if the product is found defective, the monitor will send a feedback signal to management who will take corrective action at the input, or on the process if the latter is out of adjustment.



In the production of large physical facilities, serial production is not possible since the system is normally set up to produce a single unit. Exercising control at completion or delivery of the end product only, would imply a very high risk of costly subsequent modifications. However, the construction process, devised to transform a large amount of resources by means of site labour and craftsmanship into a facility, carries with it the variability and instability of human decisions and actions. This large degree of inherent flexibility lends itself to the possibility of exercising continuous monitoring and control of quality, time and budget throughout the construction process. Project management has therefore devised techniques such as quality supervision, time scheduling and cost control, performance of which is carried out by one or more of the professional consultants appointed to the project to assist management in the conduct of specialized functions.

Program management extends beyond the project concept in being concerned with preliminary inception and final performance evaluation. It is thus concerned with the coordination of many organizations, each of them contributing its respective capabilities to the conduct of part of the program. However, each organization also responds to particular interests, and the role of program monitoring will be to ensure the convergence of all the contributors' efforts towards the stated program objectives of quality, schedule and budget. The function of program monitoring must also be exercised all along the development process, but it will take place one level higher than project controlling. If project management applies techniques that measure actual quality, cost and time, program management must ensure that proper techniques are implemented with targets congruent to the overall program preformance requirements. Program monitoring will deal with master schedule and budget, not the detailed level of every operation and how each operation will be performed. Rather, it has the responsibility to see that groups of operations are assigned under capable organizations, and that these

organizations are pursuing individual plans consistent with the master plan. Program monitoring will be most effectively implemented if management can state clearly to the functional organizations why their contribution is required, what is expected from that contribution and when it must take place in the master schedule. How it is performed remains the responsibility of the specialized function as long as it does not overrun its budget. The following graph illustrates where monitoring must take place in program management, and how evaluation must feed back to planning through the management action.



5.4 PROGRAM EVALUATION

Program management is a broader concept than project management not only because it overlooks the project activities, but also because it is involved in the evaluation of the organizational performance. This evaluation presents no practical value in a single project situation. It is essential, though, in a program where multiple projects may be undertaken in sequence. A retrospective analysis of past performance can be used as a feedback indicator as to the strengths and weaknesses of different organizational arrangements under similar circumstances. Program management must use past experience to guide the conduct of individual projects and to provide support when a project encounters difficulties at any of its stages. Since program management organizes the project team, the evaluation process must produce an overall measure of the project performance in terms of quality, time and cost, in relation to the type of organization it has selected.

The measurement of individual project performance can be taken at completion by a reading of the final cost, time and quality reports. The comparison of actual with planned, and the recording of the differences will provide a more valuable measurement. However, an evaluation that also gives some indication as to where and when something went wrong in the course of a project, has significant feedback value. A final evaluation of the project performance should be very closely related to the monitoring process. The final evaluation will thus produce a detailed history of the project, and an identification of management weaknesses, if any.

Program management provides, through the project organization, a facility that is intended to fulfil a need. The degree to which it successfully meets this

objective can be measured by a functional evaluation of the facility. Feedback information from the early utilization period of the facility may be used, in order to produce a measurement of the user satisfaction in terms of serviceability, technical performance and other relevant criteria. Thus program evaluation is two-fold:

a) evaluating the team performance;

b) evaluating the functional characteristics of the facility it has produced.

5.5 PROJECT MANAGEMENT IN A PROGRAM

a) What is Project Management

A project refers essentially to a set of coordinated tasks to be carried out in order to produce efficiently a facility as an end-product. The management of the project concerns itself mainly with coordinating and motivating the team members, and ensuring efficiency through application of the necessary control systems. In this study, project management applies to a specific assignment which is the procurement of a facility within cost, time and performance guidelines stated by program management. It is assumed that each member of the project team is competent in his own field, and the function of management becomes mainly that of organizing and coordinating in order that the project remain within cost, time and quality guidelines.

b) Project Management in a Program

Ultimately, project management is a function of the agency which needs the facility and is willing to spend some resources to procure it. In a program situation, this agency is both the sponsor and the user. It may elect to manage the project, or to employ a capable person to whom it delegates this responsibility and who acts as the procurer of the facility. The appointed project manager thus receives his authority directly from the sponsor-user group, and is accountable to them for conducting the project within guidelines. His role begins with setting up the organization appropriate to the type of project being undertaken. He will also take into account the locational environment that will provide him with the professional resources required in the conduct of the project. Once the project team is formed, the project manager acts mainly as a coordinator of the team

members. He defines roles and priorities, and controls the progress of work in accordance with his planned objectives, congruent to the guidelines determined at the program planning level. The project manager, having formed the team, is responsible for realization of the facility. When his assignment is completed he delivers a facility procured at a certain cost, within a time period, and showing certain performance characteristics. His action as project manager will be evaluated by program management against the performance of the product he delivers.

To program management, the delivery of a single facility is not an end in itself; program management pursues longer term goals such as an overall control over the resource requirements and the performance of any facility to be procured under any jurisdiction. Therefore, program management delegates to the project manager the authority necessary for him to direct and control the contribution of the team members. However, program management monitors project implementation through a reporting system of major budget and time requirements. Under this system, the project manager remains in communication with the sponsor-user representatives, who in turn will support and guide his managerial effort with feedback information from past performances. In this context, the project manager becomes essentially a PROJECT COORDINATOR - coordinating at the project level the individuals' contributions - coordinating, at the program level, the progress of the project with program management's expectations.

The monitoring by program management of the individual project is illustrated in Figure 12. The structure that integrates the two management levels is schematized in Figure 13.

PROJECT MANAGEMENT IN A PROGRAM

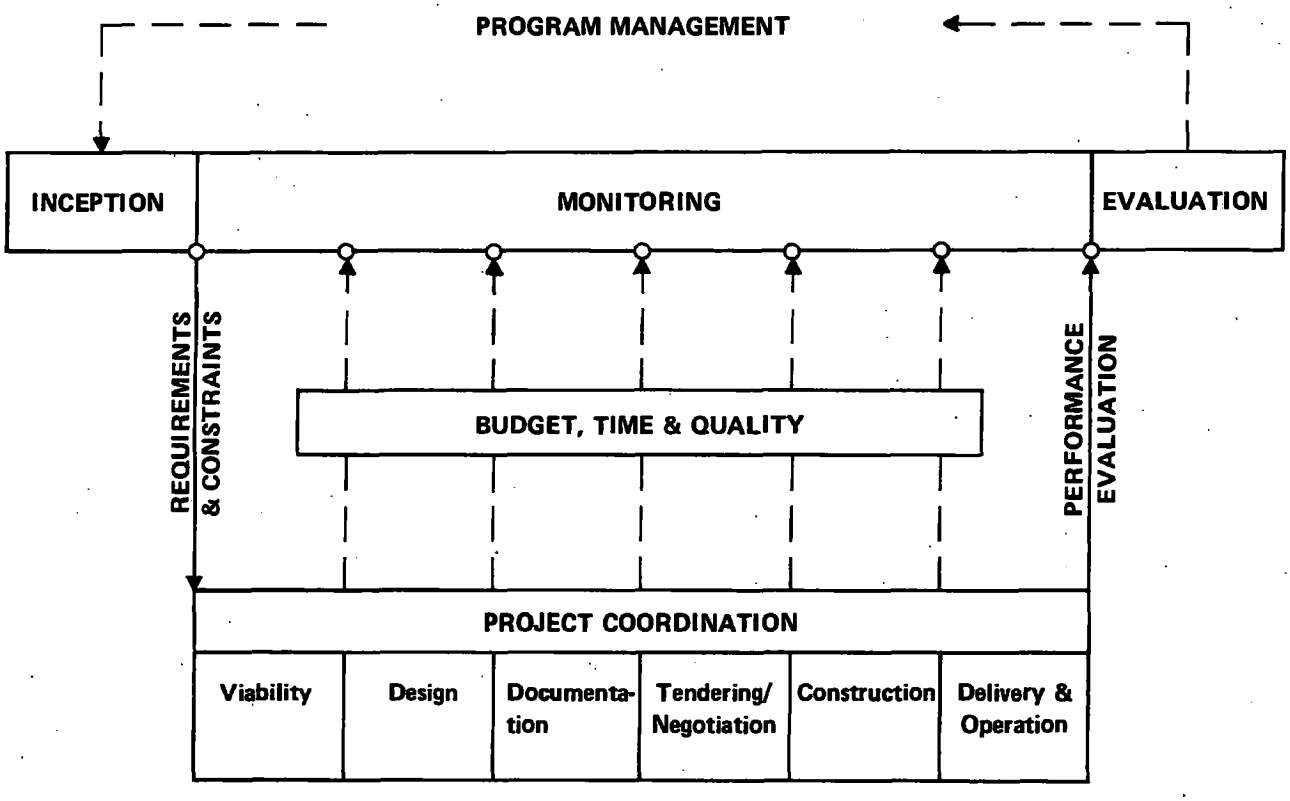


FIGURE 12

STRUCTURING THE PROGRAM ORGANIZATION

AUTHORITY	ROLE – RESPONSIBILITY	COMMUNICATION
Program Management Committee	Program Manager - overall planning for requirements - monitoring - motivation - evaluation	Management meeting
Project Planning Office	Functional offices - functional requirements planning - functional evaluation	Design meeting
Project Offices	Sponsor liaison, user representative, project team - design - implementation - control	Project meeting

FIGURE 13

6.0 THE PROGRAM MANAGEMENT MANUAL

In the previous section, a concept of Program Management has been developed, that applies to the acquisition of physical facilities. In order that this concept may be implemented, it was decided to prepare a prototype manual. The manual indicates to the user how the concept applies to individual projects, and it proposes to management an approach for the accumulation and reuse of information gathered on the projects for program purposes.

6.1 OBJECTIVES OF THE MANUAL

The manual is intended to be used as a guide for program management, to monitor individual projects, from inception to completion, under any jurisdiction. It is developed in a prototypical form to be tested in collaboration with field officers. During the testing, all procedures will be finalized, in order that the manual becomes a fully usable document.

It should be noted that the present format and terminology of the manual is oriented towards building construction. The basic concepts and procedures, however, will be found to be equally valid for civil engineering work.

The manual pursues the following objectives:

a) ease of use by the program representative;

b) comprehensiveness, to include every participant to a project;

c) clarification of the process of monitoring;

d) preparation of feedback information on individual projects;

e) utilization of feedback by program management.

The manual is presented in the form of a guide to assist the representative of the sponsor in the procurement of a facility. The sponsor representative, in the conduct of a project has the responsibility of monitoring the development of a physical facility within budget, time and performance expectations. Developing the monitoring process into three basic phases, the manual provides a general framework for the user to follow the progress of work, and it offers program management a tool to gather valuable information from every single facility it sponsors. The three phases are:

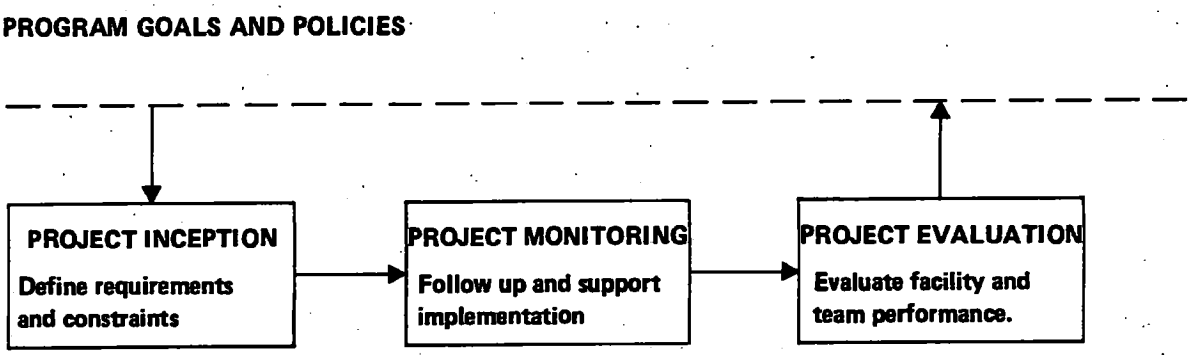
a) the establishment of expectations in terms of quality, budget and schedule at the program level;

b) the comparison of actual performance with planned progress of work continuously during the development of the facility;

c) the production of feedback information on both the performance of the facility and the organization that conducted the project.

6.2 SCOPE OF THE MANUAL

The manual assumes that Program Management has set its goals and policies and their fulfilment takes place in the realization of physical facilities subject to overall constraints. The manual is concerned with the monitoring of single projects and their interactions and interfaces with program management. It ranges therefore from the inception of the project, through the stages of project implementation and terminates with the evaluation of the project to generate feedback information. The boundaries of the manual are illustrated below:



6.3 DESIGN OF THE MANUAL

The process of the development of a physical facility is first analyzed into stages occurring in their logical sequence. For each stage, the manual states why it is undertaken as a single step, when it must take place in the process, and who is involved in its implementation.

A second degree of analysis is the activity, a certain number of activities are required under the direction of the Project Coordinator. These activities indicate the respective contributions of the many participants to the development process. They are described in a language that the professionals in the industry can understand as an indication of what must be done and who is responsible for this action.

A final analysis, to be developed during the testing of the manual, is for the user to receive a detailed description of his action as sponsor representative, when his contribution is required in the monitoring role. This description will be made by means of a procedure and a check-list against which he will be able to verify the comprehensiveness of the Project Coordinator's report. (This last analysis will be performed as the manual is tested.)

The framework of the manual follows the logical sequence of the monitoring of the development of a physical facility. It comprises three major sections subdivided in stages from A to H:

I - The establishment of the requirements:

A. Project Inception

B. Project Viability Analysis

II - The monitoring of project implementation:

C. Project Design

D. Project Documentation

E. Project Tendering/Negotiation

F. Project Construction

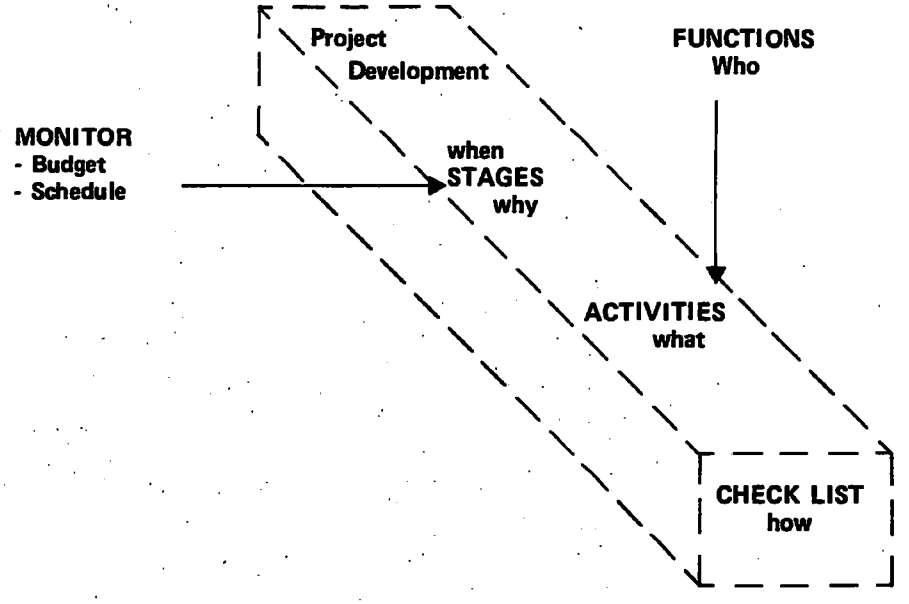
G. Project Delivery and Operation Planning

III - The production of feedback information:

H. Project Evaluation

Monitoring is effective on the three criteria of budget, schedule and quality, by means of continuous comparative measurements of the variance between actual and planned performance. The monitoring will run across the five stages (C. to G.) of the project implementation.

At the stage level, budget and time schedule are monitored. Each project implementation stage ends with a report section indicating the actual performance as compared with planned, and allowing for the user's comments on variances. The format is standardized throughout the manual in order to produce feedback information at the evaluation stage that can be revised at the inception of future projects.



7.0 RECOMMENDATIONS

7.1 GENERAL

This report has produced a review of the different Management Systems related to facility acquisition, and it proposes a concept of Program Management to select, monitor and evaluate their utilization.

Finally a guide was prepared, in the form of a prototype manual, to assist field officers in implementing the concept and providing management with a tool for gathering information at the program level. As the manual is in a draft or prototype form, we recommend that it be tested in the field, before it is placed in full scale service. The testing will permit the careful study of the user-tool interface as well as the tool-management interface. It will lead to a standard set of procedures to implement monitoring and to process the data generated.

7.2 A METHODOLOGY FOR THE TESTING OF THE MANUAL

The testing of the manual can be carried out in 3 steps:

a) the exposure of the manual to the user by means of seminars given to the field officers located in the different regions of the country. It will lead to initial familiarization with the manual by the prospective user and it will provide indications concerning the possible regional differences to be taken into account;

b) the utilization of the manual on typical projects selected on the basis of size, location and complexity, for each of the three project management systems identified in the study: Sequential/Linear, Construction Management and Turnkey. This step will provide the opportunity to establish the specific procedures to be followed by field officers, analysis of the basic framework of the manual, feedback on the effectiveness of the reporting and evaluation forms, etc.;

c) the establishment of a standard format of data generation. This step will be conducted with the participation of program management who will define their priorities and needs for useful information. The data processing required after the completion of each project will be formalized accordingly with the requirements of Program Management.

It is expected that subjecting the prototype manual to testing will lead to improvements in format and content. The contribution of users will be essential to the production of an operational document fully adapted to the needs of the Program Management concept.

case studies

D.R.E.E. PROGRAM MANAGEMENT STUDY

CASE STUDY NO. 1 (TURNKEY)

PROJECT DESCRIPTION

The purpose of this building was to carry out research into and produce in commercial quantity, bacterial vaccines. Because of the nature of the building, special emphasis was placed on environmental control and prevention of cross contamination of air between spaces.

The building, located in Toronto, has a total gross floor area of 45,300 square feet on two floors, the lower floor being a partial basement. Approximately 50% of the lower floor was left unfinished for future expansion.

The shape of the building was simple and rectangular. The client placed a low priority on exterior aesthetics but required that the design be pleasing and compatible with other buildings in a large complex.

ORGANIZATION

The owner appointed one of his own staff to integrate, coordinate and direct the users and other interested parties within his own organization. To assist him in program development, and to some extent the preparation of bidding documentation, a third party was retained. This man was a mechanical engineer working for an engineering consulting firm, which firm was a subsidiary of a holding company specializing in Turnkey contracting. Competitive tenders were called and a contract awarded for the completion of design and construction of the facility. The successful contractor

appointed a project manager to direct the project. Detailed design and preparation of production engineering was carried out by a functional unit with the normal design departments. A construction manager (called a construction coordinator) was appointed by the contractor to procure sub-trades, schedule and report on costs. Field organization was typical, operating under a superintendent. This organization is shown graphically in Schedule I.

CONTRACTUAL ARRANGEMENTS

The owner had only two contracts. The first was with the design consultant for the supply of one man on a per diem basis to assist in program development. The second was a lump sum contract to design and build the facility. This latter contract was drawn up by the owner but contained the same basic clauses and philosophy of C.C.A. contract No. 12. Minor modifications were made to include the word "design" in scope of work and an addenda added to explain the procedure for processing sales tax rebates applicable to this project.

The contractor entered into a standard design contract with his own subsidiary for architectural, structural and mechanical working drawings and design supervision. Because in-house electrical skills were not available, the contractor entered into a similar contract with an independent electrical consultant. The majority of the work in the field was sub-contracted using standard documentation. Contractual relations are shown graphically in Schedule II.

CONTROL

Control of cost, time and quality was divided into two phases - pre-contract and post-contract. From the results it would appear that a low priority was placed on time and cost control in the pre-contract phase. No organized cost planning or

scheduling was carried out. On the other hand, because of the nature of the project, high priority was placed on quality control, especially in the pre-contract phase. This is evidenced by the abnormally extensive specification document, abnormal that is in comparison with the majority of turnkey projects. Conversely, after the contract was signed the responsibility of control rested with the successful contractor. It was in his interest to exercise strong control over cost and time. A fairly sophisticated cost report was prepared monthly. Monitoring of schedule was carried out on a bar chart. Control of quality after signing contract was the responsibility of the contractors, design consultants with independent testing agencies used for roofing, soils, fill, steel and concrete.

COMMENT AND CONCLUSIONS

As far as organization and management is concerned this project is classified in the turnkey family. The extent of design input from the client before tendering was above average for this type of contract and therefore should have had the effect of minimizing the spread of prices quoted. This was not the case, as some of the proponents were not organizations regularly involved in turnkey contracting. Their entry into the field was probably occasioned by a market condition, namely a general lack of work in the industry.

The extent of design carried out before tendering should also have had the effect of minimizing the time lapse between bid and award (two months). This again was not the case. This can be explained in two ways. Firstly by the inclusion of firms not experienced, meaning that bids were very different and, secondly, by the nature of the owner (institutional) and his lack of experience in evaluating turnkey bids.

The owner had the normal advantage that a turnkey contract affords, namely of knowing the end price (within reasonable limits) before commencement of detailed working drawings. Changes to the

contract were average (approximately an increase of 5% offset by a negative adjustment in an allowance). The owner was confident that he benefited from the down-to-earth approach of the design team which had good feedback from the construction people.

As far as saving time is concerned, this is debatable. The length of time required to draw up bidding documents, prepare bids, analyze results and award a contract was 6 months. This time, according to the design director, would have been adequate to complete working drawings and specifications for a general contract bid. In this respect it is interesting to note that construction commenced in December, a bad month considering the type of building (poured concrete basement and poured concrete second floor construction). Further, it could be said that utilizing a construction management technique could have placed construction start at the end of summer with consequent savings in winter conditions cost. On the other hand, the owner would have had to exercise more project management over the whole process in this event, and would not have had the advantage of knowing the end price before commencing construction.

In conclusion, the main advantages to the owner of utilizing the turnkey technique on this project would appear to be as follows:

a) fixed price contract before commencement of working drawings;

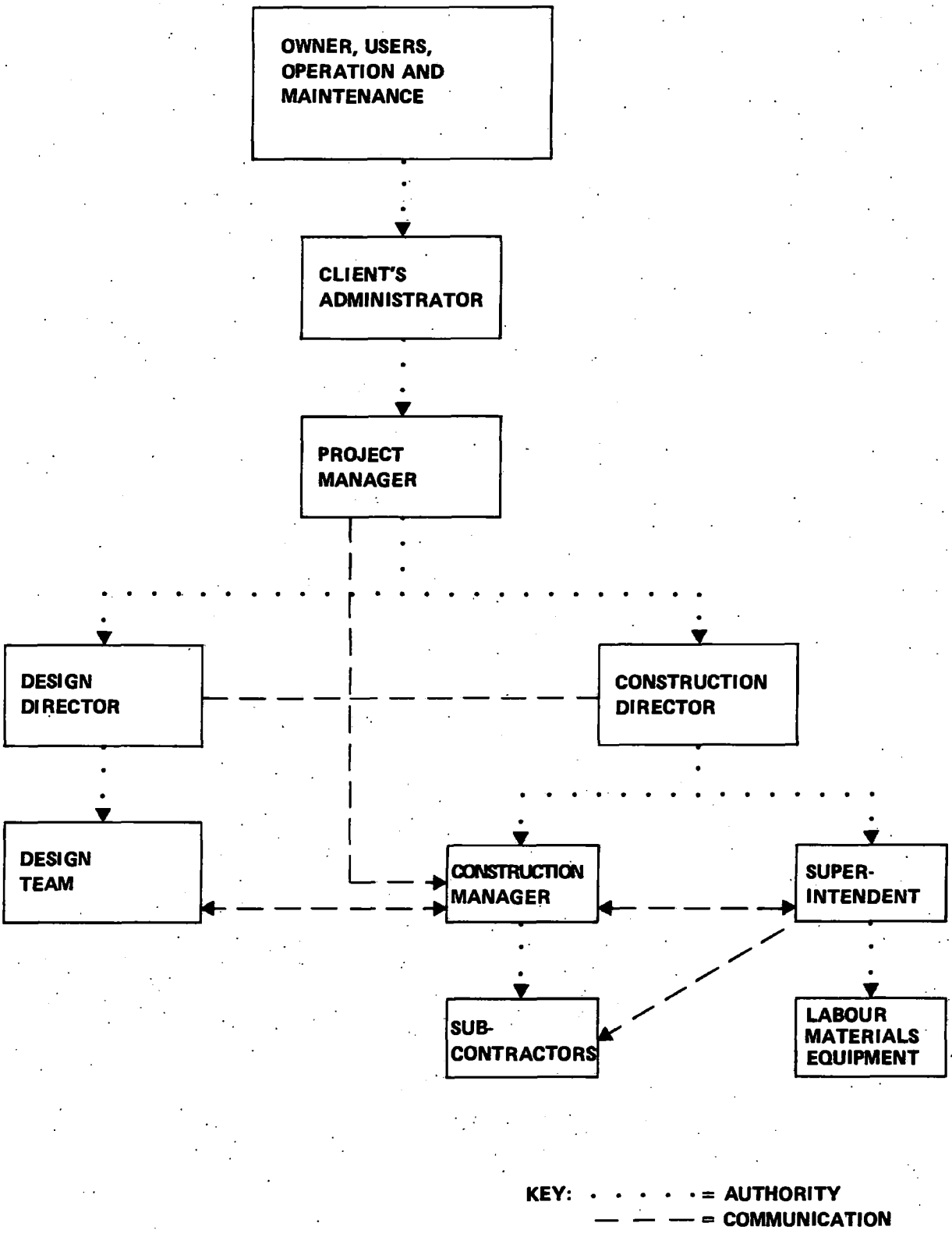
b) no problems regarding interface between design and construction management team;

c) a design team with greater exposure to feedback from construction process;

d) a choice of alternatives at the bid stage, complete with bid prices. Competition for detailed design as well as construction.

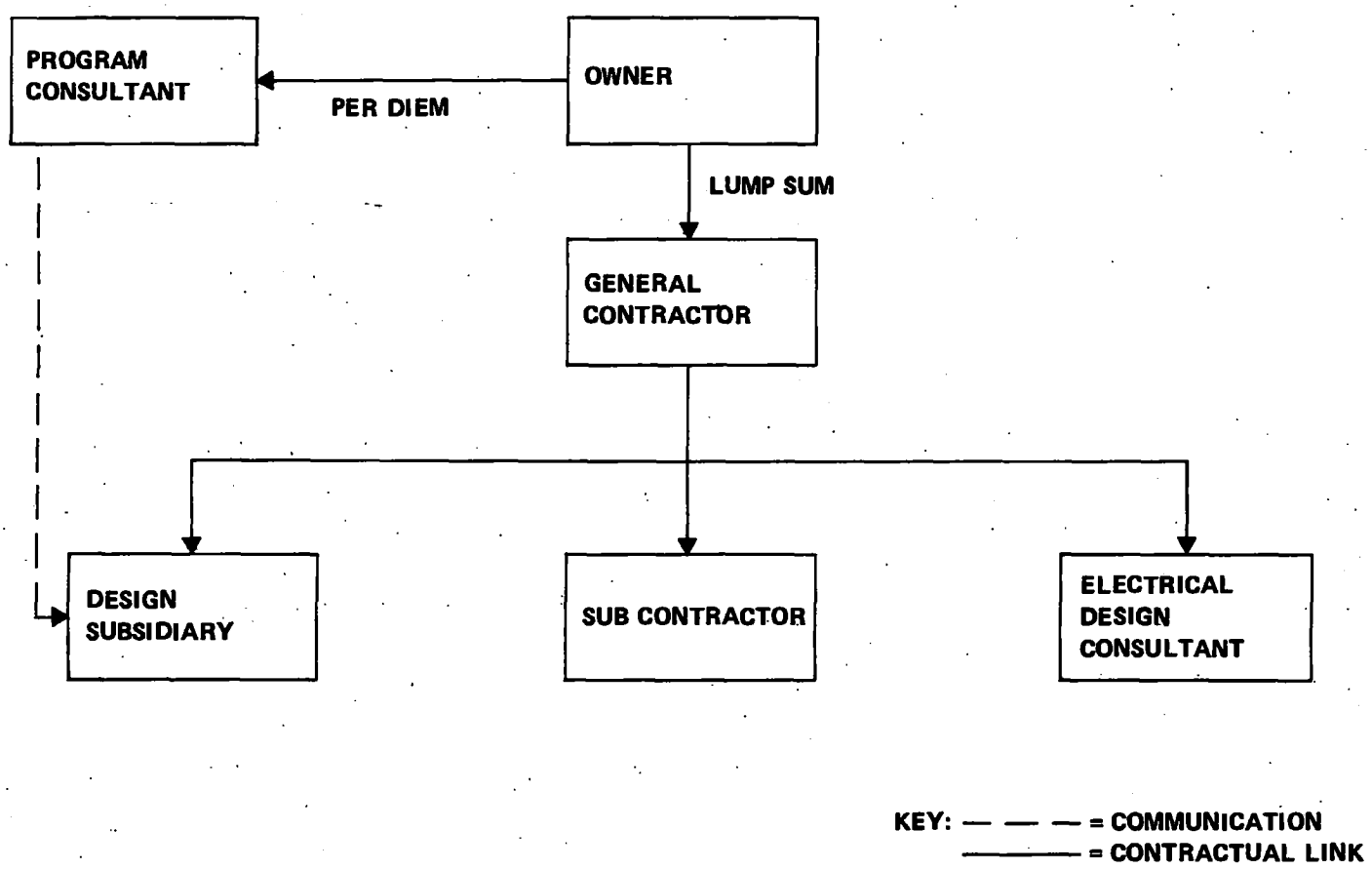
CASE STUDY NO. 1

SCHEDULE I
MANAGEMENT ORGANIZATION



CASE STUDY NO. 1

SCHEDULE II – CONTRACTUAL ARRANGEMENTS



CHRONOLOGICAL PROCESS:

CASE STUDY NO. 1, p. 5

DATES	TASKS PERFORMED	TIME IN MONTHS	PERSONNEL INVOLVED
1956 to 1969	FEASIBILITY STUDY, PRELIMINARY PLANNING: Need recognized and analyzed. Alternatives (renovating existing buildings, linking or expanding them or new building). Decision made to build new building and site selected.	150	Owner's staff
1969 to Sept.1970	PRELIMINARY PROGRAM: Identification of major problems, obtaining World Health Organization (W.H.O.) approval, development of program to this end including preparation of sketch plans (required by W.H.O.) and design parameters. Decision to utilize turnkey method of procurement.	12	Owner's staff and W.H.O. officials and consultant
Sept.1970 to May 1971	DEVELOPMENT OF PROGRAM: Program developed and budget set and approved by governing body. Some detail design carried out in major problem area namely air distribution and refrigeration.	8	Owner's staff and consultants
May 1971 to July 1971	PREPARATION OF TENDER DOCUMENTS: Outline specification developed and tender documents prepared; some detail specifications produced at this stage, mostly for elements of special nature. Preparation of list of bidders and request for tender.	2	Owner's project administrator and consultant
July 1971 to 1 Sept. 1971	TENDER PERIOD. OUTLINE DESIGN: Six companies prepared tenders consisting of an outline design for the majority of the project including exterior cladding, structural design, mechanical and electrical detail schematics. Estimates prepared (often supported by sub-trade) procurement process initiated.	1	6 separate contractors, their estimators, designers and construction personnel

CHRONOLOGICAL PROCESS:

CASE STUDY NO. 1, p. 6

DATES	TASKS PERFORMED	TIME IN MONTHS	PERSONNEL INVOLVED
Sept. 1971 to 28 Oct. 1971	ANALYSIS OF BIDS AND SELECTION OF CONTRACTOR: Bids analyzed on the basis of price, quality of proposal and capacity and reputation of bidder; wide range of prices ranging from marginally over original budget to 50% over. Quality of product ranged from slightly sub-standard to "gold plated Cadillac" (client's own words). Proponents ranged from integrated turnkey contractors with 90% in-house capacity to ad hoc temporary "marriages of convenience" between design consultants and general contractor. Contract awarded.	2	Owner's project administrator, consultant, governors of institutional body
28 Oct. 1971 to 12 Nov. 1971	FINAL DESIGN CHECK: Thorough investigation of successful tenderer's proposal to verify items and clarify intent. Approval to continue detail design and preparation of production information.	½	Owner's project administrator and successful contractor's design team
Nov. 1971 to 31 Mar. 1972	DETAIL DESIGN AND PREPARATION OF PRODUCTION INFORMATION: Complete working drawings and a minor amount of detail specification prepared. This process previously started in "Tender Period" above. Cost checking of design carried out concurrently, to ensure detail design did not exceed original intent. Preparation of drawings governed by construction schedule.	4	Contractor's design consultants, estimator, project manager

CHRONOLOGICAL PROCESS:

CASE STUDY NO. 1, p. 7

DATES	TASKS PERFORMED	TIME IN MONTHS	PERSONNEL INVOLVED
30 Dec. 1971 to 18 Jan. 1973	PROCUREMENT PROCESS AND CONSTRUCTION: Sub-trade tenders called and awarded as and when required: work in the field carried out under direct control of superintendent with help from construction manager. Quality control carried out by design team, cost and time control by the construction manager; overall project managed by project manager. (Note: overlap with previous task.)	13	Contractor's full complement of staff
18 Jan. 1973 to 1 June 1973	FURNISH, EQUIP AND OCCUPY: Building furnished and equipped by owner; occupancy commenced March 5, 1973; completed except for 50% of basement left unfinished.	4½	Owner

TIME SCHEDULE

CASE STUDY NO. 1, p. 8

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
1968												
1969	1											
1970									2			
1971					3		4		5	6	7	8
1972			9									
1973	10		11			12						

1. Jan. 69 Decision to build new building
2. Sep. 70 Approval by World Health Organization
3. May 71 Approval of budget
4. Jul. 71 Request for tenders
5. 01 Sep. 71 Receipt of tenders
6. 28 Oct. 71 Award of contract
7. 12 Nov. 71 Start detail design
8. 20 Dec. 71 Start construction
9. 31 Mar. 72 Complete detail design, working drawings and tender documents
10. 18 Jan. 73 Complete construction, start of finishing
11. 05 Mar. 73 Initial occupancy
12. 01 Jun. 73 Complete finishing and occupancy

D.R.E.E. PROGRAM MANAGEMENT STUDY

CASE STUDY NO. 2 (CONSTRUCTION MANAGEMENT)

PROJECT DESCRIPTION

The building houses a university's Faculty of Management and School of Languages. Located in Montreal, it has a total gross floor area of 179,080 square feet on 8 floors, two below grade, one of which is a garage. Above grade, there are four main floors of offices, one floor accommodating a library and one floor of classrooms and service areas. The floor immediately below grade also consists of classrooms and service areas.

The concept is rectangular with a central core containing elevators, stairs and facilities.

The exterior design was required to be approved by the university's Architectural Committee, to ensure that it was compatible with the balance of the campus.

ORGANIZATION

The Department of Physical Plant of the university integrates the desires of the users (in this case, a committee formed by the Faculty of Management and School of Languages) into both the program and the preliminary design phases for all new construction on campus, and the architect and management consultants (cost and time control) reported directly to the Director of this Department.

Competitive tenders were called in two phases for:

a) demolition and bulk excavation;

b) general contract to complete the facility.

The same contractor won both contracts and field organization was operated typically under a superintendent. The contractor employed a general superintendent looking after this job plus one other on campus, and a contracts manager also overseeing the work (in particular the larger extras and claims). The management consultant had a cost analyst on site, the university a clerk of works. This organization is shown graphically in Schedule II.

CONTRACTUAL ARRANGEMENTS

The university awarded 4 contracts: one with the architect, one with the management consultant, and two with the general contractor, as mentioned above (both of which were lump sum). The work in the field was sub-contracted, using standard documentation. The management consultant represented the owner in negotiating and approving all extras to the contracts during construction. Contractual relations are shown graphically in Schedule II.

CONTROL

Control of cost, time and quality was divided into two phases - pre- and post-contract. From the results, it would appear that all three items received equal priority during the pre-contract phase. Cost planning and cost control were carried out by the management consultant, along with the scheduling of the design work.

After construction contracts were signed, time and cost control remained essentially with the management consultant, acting on behalf of the university. The general contractor objected to this, as he preferred to keep sole control of his sub-contractors in the traditional manner, and felt that the negotiation of extras, etc., by others was interference (without commitment).

The construction schedule was prepared by the management consultant in conjunction with the general contractor and monitoring was carried out by the consultant. The building was occupied up to the fourth floor at the beginning of the school year, even though the building was not essentially complete.

Control of quality after signing of the contract was the responsibility of the architect, contractors and testing agencies used for roofing, soils, steel and concrete. The university, through the Department of Physical Plant at the weekly job meetings, also contributed a fair amount of input to the control of quality, cost and time.

COMMENTS AND CONCLUSIONS

The university achieved its stated goals on this project, although not without difficulty. The major achievement was in obtaining a building of reasonable quality, functional for the intended use, and within budget. Also, the prime user was able to take occupancy at the commencement of the school year.

The management consultant was appointed primarily for cost control; this was done partially to satisfy the requirements of the Provincial Department of Education, which finances part of the campus construction through grants. By exercising cost control during the design and working drawing period, savings were achieved (where required) before tendering. By phasing the construction, but maintaining a lump sum contracting procedure, the university knew its total commitments in sufficient time to permit cancellation or delay of the project, or an increase in budget, in the event that overruns occurred. As it turned out, this was not necessary.

During construction, changes and extras amounted to roughly five per cent of the contract value. Part of the reason for the good performance in relation to budget was the market condition at the time of tender; many contractors looking for work at the same time, resulted in very competitive bidding.

Closer examination however reveals difficulties:

a) a loss of six months time investigating the commercial rentability of part of the building;

b) a loss of three months time due to zoning problems with the city during the working drawing stage.

These delays were partially offset by the decision to utilize phased tendering, and by the management consultant's expediting the general contractor throughout construction, through the monitoring of the schedule.

Also, due to delays very close to the time of tendering, and shortage of staff, the architect arranged for the specification to be written by a professional specification writer. The results were not ideal for two reasons: an outsider could not be expected to become even reasonably familiar with the job in the short space of time available, and the owner had considerable input and comments; this could not reasonably have been assimilated by someone not fully familiar with the project.

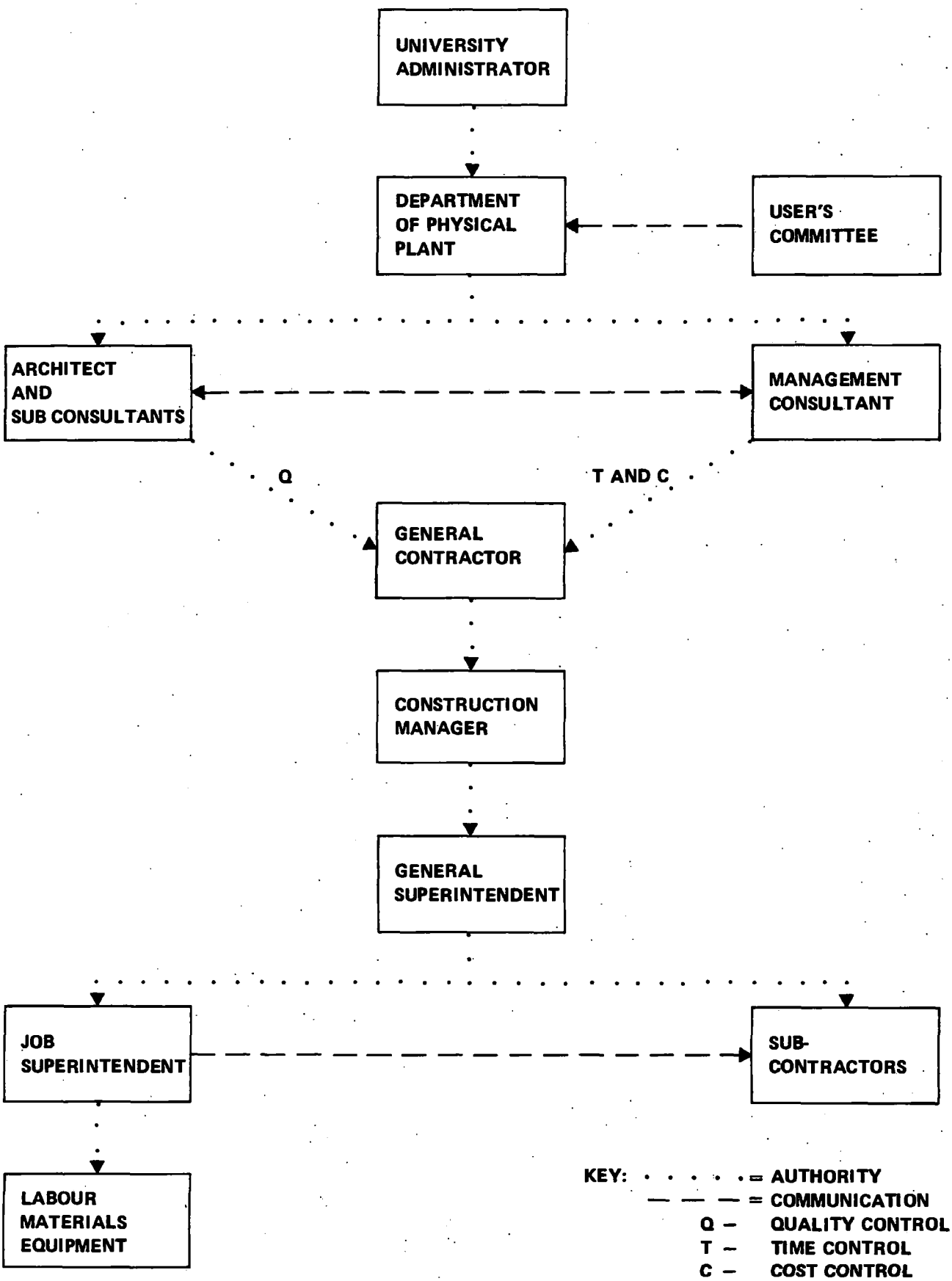
From the point of view of the general contractor, not only was he subjected to the normal supervision of the architect, but cost and time control were exercised separately by the management consultant. The contractor considered the latter strictly as an agent of the owner, and felt that any direct dealings with the sub-contractors (for extras or scheduling-manpower, for example) were not within the owner's contractual right. In addition, the owner's representatives (Physical Plant Department, architect and management consultants) attended all job meetings. The contractor claimed he was being directed on the job by too many people and that only one of the aforementioned group should have represented the university.

If the rentability options had not been pursued, had there been no problems with the city and had the job been tendered as one contract, the cost results and project delivery would most likely

have remained the same. There are always problems and delays and the owner obtained his desired results by taking out a form of insurance policy: the management consultant. This partially offset potential difficulties, even with lump sum tendering, because the owner then had some independent and specialized expertise to call upon when necessary. Many of the problems experienced by the general contractor on this job in relation to overall control, were contractual and could have been avoided by a better contract document.

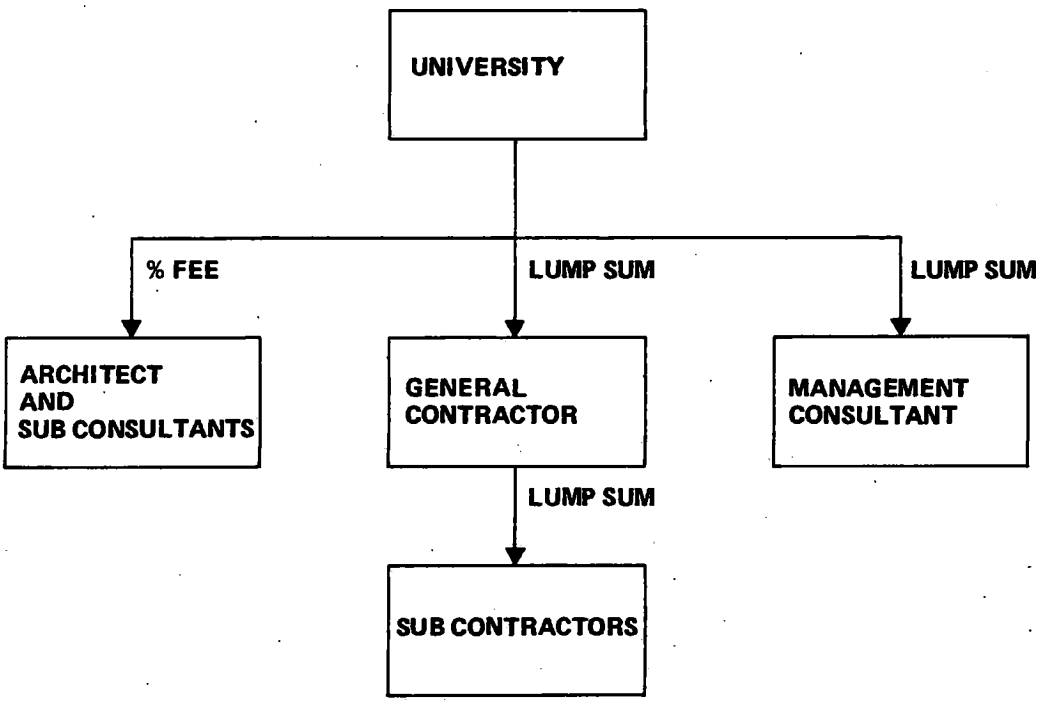
CASE STUDY NO. 2

SCHEDULE I
MANAGEMENT ORGANIZATION



CASE STUDY NO. 2

SCHEDULE II – CONTRACTUAL ARRANGEMENTS



KEY: ———— = CONTRACTUAL LINK

CHRONOLOGICAL PROCESS:

CASE STUDY NO. 2, p. 6

DATES	TASKS PERFORMED	TIME IN MONTHS	PERSONNEL INVOLVED
Mar. 69 to Jan. 70	PRELIMINARY PROGRAMMING AND PLANNING Site previously selected. Development of program to suit users, O & M staff, including preparation of sketch plans and design parameters. Alternatives (mainly related to extra stories for renting commercial space) investigated.	11	Owner's staff Architect
Feb. 70 to Apr. 70	FEASIBILITY STUDY Viability of University renting out commercial space investigated.	3	Physical Plant Dept. Architect Management Consultant Trust Company
May 70 to July 70	FEASIBILITY STUDY REVIEW Decision taken not to pursue rental proposal.	3	Owner's staff
Aug. 70 to Sep. 70	COMPLETION OF PRELIMINARIES Program confirmed and verified. Areas defined, and sketch plans and outline specifications completed. Budget set and approved by governing body. Decision taken to utilize phased tendering (lump sum contracts).	2	Owner's staff Architect Management Consultant
Oct. 70 to June 71	PREPARATION OF TENDER DOCUMENTS-PHASE I (DEMOLITION AND BULK EXCAVATION) Completion of detail drawings and specifications. Preparation and approval of tender documents and cost check against budget.	8	Physical Plant Dept. Architect Management Consultant

CHRONOLOGICAL PROCESS:

CASE STUDY NO. 2, p. 7

DATES	TASKS PERFORMED	TIME IN MONTHS	PERSONNEL INVOLVED
Oct. 70 to Oct. 71	PREPARATION OF TENDER DOCUMENTS-PHASE II (COMPLETE JOB) Completion of detail drawings and specifications. Preparation and approval of tender documents and continuous cost checks. Review and changes by City Planning Department.	13	Physical Plant Dept. Architect Management Consultant
23 June 71 to 21 July 71	TENDER PERIOD-PHASE I Four companies prepared tenders based on stipulated sum bid (plus unit prices for extras).	1	4 separate contractors, their estimators mostly involved
21 July 71 to 2 Aug. 71	ANALYSIS OF BIDS AND SELECTION OF CONTRACTOR-PHASE I Contract awarded.	0.50	Owner's staff Architect Management Consultant
02 Aug. 71 to 20 Dec. 71	CONSTRUCTION-PHASE I Demolition of existing buildings and bulk excavation. Job stopped in November due to permit difficulties and change to basement size by city.	5	Physical Plant Dept. Architect Management Consultant Contractor
01 Nov. 71 to 25 Nov. 71	TENDER PERIOD-PHASE II Nine companies prepared tenders based on stipulated sum. Sub-contractors' bids came through bid depository closing 48 hours before generals. Prices requested with 15 day and 90 day limit.	0.75	9 separate general contractors (plus 126 sub-contractors)

CHRONOLOGICAL PROCESS:

CASE STUDY NO. 2, p. 8

DATES	TASKS PERFORMED	TIME IN MONTHS	PERSONNEL INVOLVED
25 Nov. 71 to 8 Dec. 71	ANALYSIS OF BIDS AND SELECTION OF CONTRACTOR-PHASE II Contract awarded.	0.50	Owner's staff Architect Management Consultant
8 Dec. 71 to Dec. 72	CONSTRUCTION-PHASE II Work in field carried out under control of general superintendent and job superintendent with time and cost control by management consultant and architect seeing that job was carried out in accordance with plans and specifications.	12	Physical Plant Dept. Contractor Architect Management Consultant
Aug. 72 to Dec. 72	FURNISH, EQUIP AND OCCUPY BUILDING Building furnished and equipped by owner. Late completion due to elevator strike delaying occupancy of top 2 floors, enabling owner to keep deficiency lists open. Essential completion-beginning of school year - Sept. 72.	5	Owner

TIME SCHEDULE

CASE STUDY NO. 2, p. 9

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
1967												
1968												
1969			1									
1970	2			3			4		5			
1971						6 7	8	9		10	11 12	13 14
1972								15				16

1. Mar. 69 - Start programming and planning
2. Jan. 70 - Start feasibility study
3. Apr. 70 - Complete feasibility study
4. Jul. 70 - Project stopped
5. Sep. 70 - Project started
6. Jun. 71 - Completion of tender documents-Phase I
7. 23 Jun. 71 Request for tenders-Phase I
8. 21 Jul. 71 - Receipt of tenders-Phase I
9. 02 Aug. 71 - Award contract-Phase I, start construction
10. Oct. 71 - Completion of tender documents-Phase II
11. 01 Nov. 71 - Request for tenders-Phase II
12. 25 Nov. 71 - Receipt of tenders-Phase II
13. 08 Dec. 71 - Award contract-Phase II
14. 20 Dec. 71 - Complete construction-Phase I, start construction-Phase II
15. Aug. 72 - Start furnishing, equipping and occupancy
16. Dec. 72 - Phase II substantial completion, complete occupancy

D.R.E.E. PROGRAM MANAGEMENT STUDY

CASE STUDY NO. 3 (TURNKEY)

PROJECT DESCRIPTION

The project was conceived in response to a need to provide head office accommodation in Edmonton for a federal government commission previously housed in Ottawa.

The building as realized contained a gross floor area of 45,000 square feet which included a basement of 5,000 square feet, the balance being on two floors.

The office was simple and rectangular in shape, the main staircase providing a feature to the building.

The area built exceeded the client's present need but allowed for future expansion, the surplus being presently leased to a separate commercial organization.

ORGANIZATION

The owner had a large staff constantly involved in contracting with private industry for projects - mostly of a civil engineering nature - and therefore assigned this project to one of his senior men. In the pre-contract phase this man acted as project manager, effectively integrating and directing the collection of data regarding the needs of the user. Lacking experience in the architectural field and in the area of budgeting this type of project, he retained the services of an independent consultant quantity surveyor to assist in the preparation of turnkey bidding documents and to ensure that these would result in a quotation within budget.

Once a contract was awarded, the management role was assumed by the successful contractor with the same client representative approving requests for payments and providing further information as and when required.

At that point the successful contractor appointed a job captain who integrated the design and construction functions to ensure that the intent of the contract was realized within the contractor's own budget. Construction was organized in the traditional way under the leadership of a superintendent. This organization is shown graphically in Schedule I.

CONTRACTUAL ARRANGEMENTS

Being of the turnkey family, the owner had just one lump sum contract for the design and construction of the facility. The contractor entered into standard design contracts for design services with an independent architect and engineers. Documentation and contractual relationships between the contractor and trade contractors were of a traditional, standard type. Contractual relations are shown graphically in Schedule II.

CONTROL

This project was achieved somewhat ahead of schedule, comfortably within budget and provided a somewhat better than average level of quality. To a certain degree, the achievement of these goals could have been attributed to adequate budgets for cost and time when related to quantity and quality levels of the required product. However an important aspect of control is the establishment of attainable goals by rational decision making in the initial programming. The client had considered locating in the downtown core but decided instead to purchase land in the outskirts of town, thus allowing more design flexibility and saving some of the total project budget. The time framework was improved considerably by

the early realization during initial planning, that a suggested occupancy date one year earlier than actually achieved, was not feasible. The one year delay did not adversely affect the client in any way and allowed more time for planning. The management system adopted assisted the time schedule by allowing overlap of construction and design.

The client therefore in the pre-contract phase obtained control through careful planning and even in the final stages of this phase sought an independent check on time and cost through his consultant.

Control of cost, time and quality after contract rested mostly with the contractor who was profit motivated to achieve the former two and who had hired a competent design team to ensure that quality levels were reached.

COMMENTS AND CONCLUSIONS

This project is classified in the turnkey family. One of the most interesting aspects of this project was the freedom allowed the proponents as far as architectural design was concerned. This had the effect of providing real competition not only for the preparation of production information and construction but also for design. The client received five proposals, each one different in appearance and layout. This naturally made analysis of bids more difficult but with the help of the quantity surveying consultant a rational method was successfully developed.

Another feature was the inclusion of a significant amount of cash allowances which allowed the client to more readily evaluate bids and gave him greater flexibility. Normally a large proportion of allowances (in this case in excess of 15% of the total project cost) would tend to detract from the "fixed price" aspect of a turnkey contract. However, in this case the bidders fixed their own allowances and were required to provide a detail description of what was included. Consequently, no major problems were encountered in their administration.

One advantage of the turnkey approach which appealed more specifically to this client was the minimal amount of input, from a management standpoint, that was required. This was especially important as the project was located over 1,500 miles from the client's head office. In fact, the client was able to assign the administration of the contract on a part-time basis to one of his existing local staff.

One of the advantages commonly claimed by turnkey contracting is the saving of time over a traditional system, due to overlap of construction and design. As in Case Study No. 1, this project does not bear this out. To illustrate this, traditionally an architect and design team could have been appointed in July 1972, allowing five months for design and one month for tender and award. Construction would have begun comfortably in mid-January. Again a construction management technique could have effected some savings in time.

In conclusion, the main advantages that accrued to this owner by the use of a turnkey method would appear to have been as follows:

a) fixed price contract before commencement of working drawings;

b) elimination of problems relating to interface between design and construction;

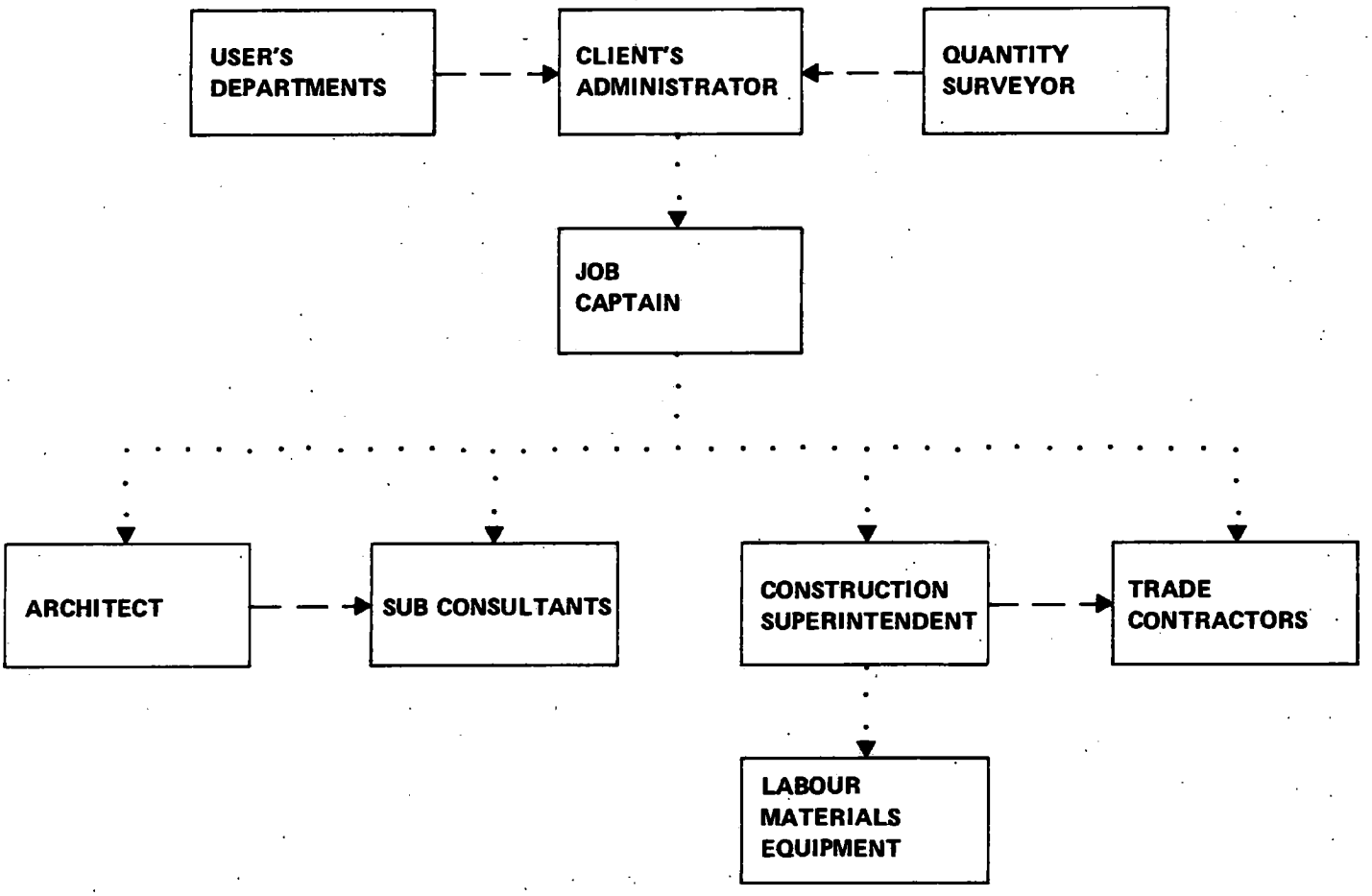
c) competition for design as well as construction;

d) minimal management input required of owner;

e) project management (by the contractor) which was informed in the construction process and sympathetic towards design.

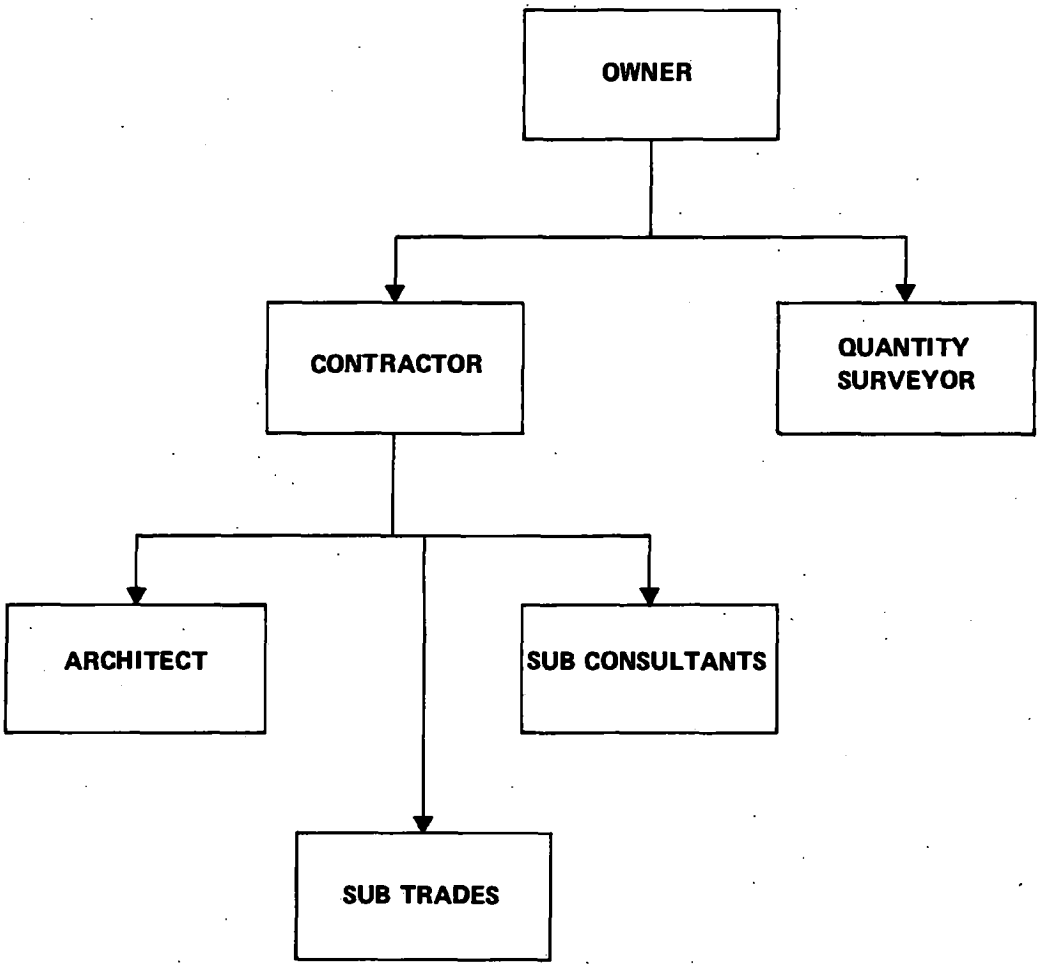
CASE STUDY NO. 3

SCHEDULE I
MANAGEMENT ORGANIZATION



KEY: . . . . . = AUTHORITY
— — — = COMMUNICATION

SCHEDULE II
CONTRACTUAL ARRANGEMENTS



KEY: ——— = CONTRACTUAL LINK

CHRONOLOGICAL PROCESS:

CASE STUDY NO. 3, p. 5

DATES	TASKS PERFORMED	TIME IN MONTHS	PERSONNEL INVOLVED
Jun. 71 to Sep. 71	FEASIBILITY STUDY, PRELIMINARY PLANNING Need recognized and analyzed. Decision taken to proceed and site selected.	4	Owner's staff
Sep. 71 to Jun. 72	PROGRAM DEVELOPMENT Identification of major problems, development of program including preparation of outline plans and performance specifications. Approval to proceed with tender call on the basis of developed budgets.	10	Owner's staff Quantity surveyor
Jun. 72 to Aug. 72	PREPARATION OF TENDER DOCUMENTS Outline specifications completed and tender documents prepared. Preparation of list of bidders and request for tender.	3	Owner's staff Quantity surveyor
Aug. 72 to Oct. 72	TENDER PERIOD, OUTLINE DESIGN Five companies prepared tenders consisting of an outline design. Estimates were prepared and procurement process initiated.	3	5 separate contractors, their estimators, designers and construction personnel
Oct. 72 to Nov. 72	ANALYSIS OF BIDS AND SELECTION OF CONTRACTOR Bids analyzed on the basis of price, quality of proposal and capacity and reputation of bidder. Contract awarded.	1	Owner's staff Quantity surveyor

CHRONOLOGICAL PROCESS:

CASE STUDY NO. 3, p. 6

DATES	TASKS PERFORMED	TIME IN MONTHS	PERSONNEL INVOLVED
Jan. 73 to July 73	PROCUREMENT PROCESS AND CONSTRUCTION Sub-trade tenders called and awarded as and when required: work in the field carried out under the direct control of superintendent. Quality control carried out by design team.	7	Contractor's full complement of staff

TIME SCHEDULE

CASE STUDY NO. 3, p. 7

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
1968												
1969												
1970												
1971						1			2			
1972						3		4		5	6	
1973	7						8					

1. Jun. 71 - Start of feasibility analysis
2. Sep. 71 - Decision to proceed, start program development
3. Jun. 72 - Federal Government approval to proceed
4. Aug. 72 - Completion of bidding documents, request for tenders
5. Oct. 72 - Receipt of tenders
6. Nov. 72 - Contract signed
7. Jan. 73 - Construction start
8. Jul. 73 - Construction complete

D.R.E.E. PROGRAM MANAGEMENT STUDY

CASE STUDY NO. 4 (SEQUENTIAL/LINEAR)

PROJECT DESCRIPTION

The building is a home for the elderly, housing 208 occupants. Located in Montreal, it has a total gross floor area of 80,997 square feet on 10 floors, consisting of one below grade (part of which includes the cafeteria and kitchen) and above grade the ground floor and eight typical residence floors, plus a mechanical penthouse.

The ground floor comprises a reception area, administrative offices, common room and residents' rooms.

The concept is generally rectangular, with reception, cafeteria, etc. in a podium-like appendage to the main residence tower.

ORGANIZATION

When provincial funds for this type of accommodation first became available, a community needing such a service formed a local "Corporation" to oversee construction and operation. At the time of the formation of the Corporation for the subject project, norms and general requirements had not been established.

Before commencing design, the architect (who reported directly to the Corporation throughout the project) carried out a research study into existing homes, social aspects involved, choice of site and environment, function of rooms and special requirements for the aged. This study was carried out in great detail and the resulting program and sketches were based on this report. New ground was being broken and the Corporation's input to the program and preliminary design phases was minimal.

The Corporation approached the Government and requested invited bids; public funds being used, this request was denied and competitive public general contract tenders were called for. The job was awarded to the low bidder.

The contractor employed a general superintendent full-time in the field, supervised by a field engineer. The architect and consultants employed staff for field supervision as required. This organization is shown graphically in Schedule I.

CONTRACTUAL ARRANGEMENTS

There were two main contracts with the Corporation: one with the architect and one with the contractor (lump sum). The work in the field was sub-contracted, using standard documentation. The architect represented the owner in negotiating and approving all extras to the contract during construction. Contractual relations are shown graphically in Schedule II.

The interiors were architect designed and bid separately later, during construction. Forty or more individual orders were placed directly by the Corporation.

CONTROL

Control of cost, time and quality was carried out solely by the architect throughout. From the results, it appears that cost was the most important factor, although quality has not been entirely sacrificed. Construction time was extended as a result of the architect's insistence that all work be done according to the letter of his specifications.

COMMENTS AND CONCLUSIONS

This project is a traditional sequential/linear one, with one contractor carrying out the work on a lump sum tender basis and separate architectural design.

The Corporation achieved its goal of having a facility at a reasonable price, and being very functional for the intended use. The residents themselves seem satisfied.

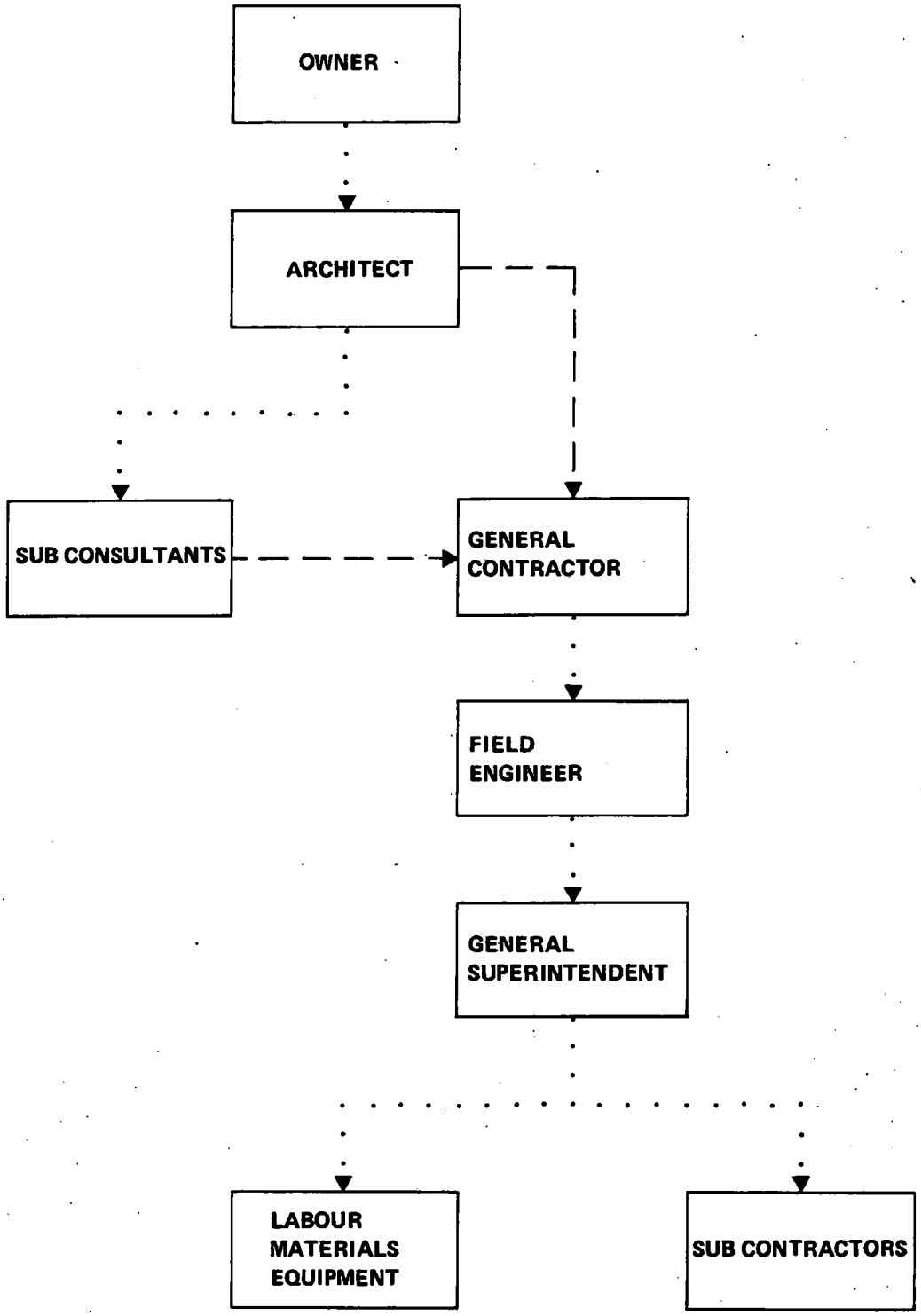
By carrying out an intensive pre-design study, the architect was able to plan the facility exceedingly well. However, if he had spent more time in coordinating working drawings, many of the conflicts between himself and the contractor would have been avoided.

By using a public lump sum tendering procedure, the Corporation knew what the total commitment was going to be, giving them the opportunity to request more funds from the Government before starting the project. As it turned out, this was not necessary since the low bid was within budget.

During construction, changes and extras amounted to roughly 3.5 per cent of contract value.

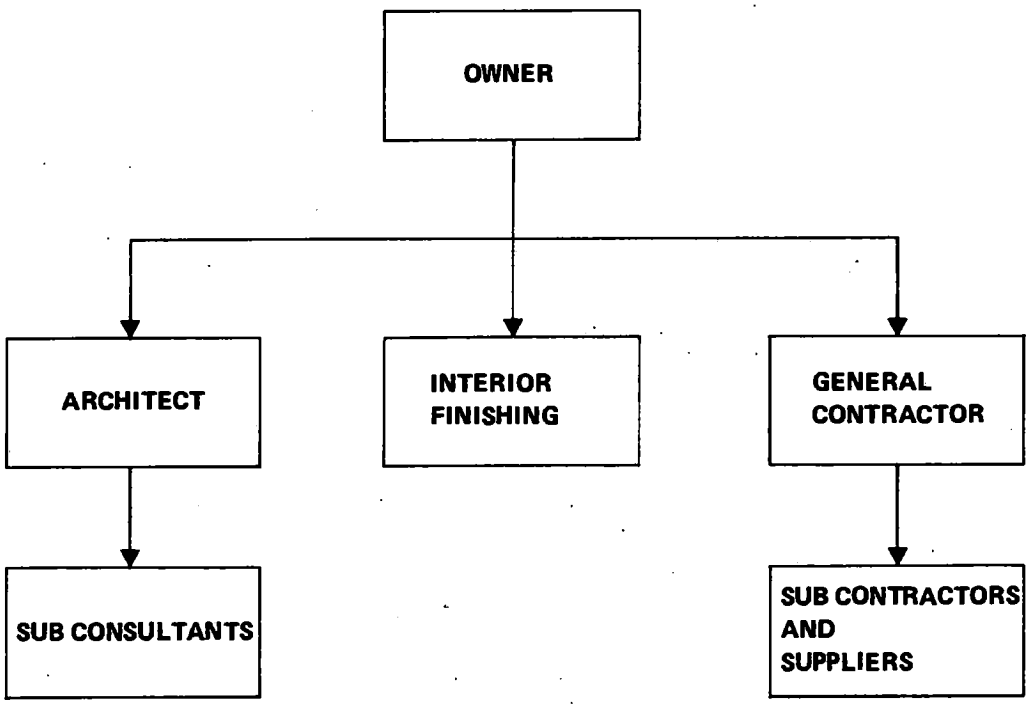
CASE STUDY NO. 4

SCHEDULE I
MANAGEMENT ORGANIZATION



CASE STUDY NO. 4

SCHEDULE II
CONTRACTUAL ARRANGEMENTS



KEY: ———— = CONTRACTUAL LINK

CHRONOLOGICAL PROCESS:

CASE STUDY NO. 4, p. 4

DATES	TASKS PERFORMED	TIME IN MONTHS	PERSONNEL INVOLVED
Apr. 69 to Nov. 69	RESEARCH STUDY, PRELIMINARY PLANNING Need recognized and analyzed. Research into existing facilities. Site investigation made.	8	Architect
Nov. 69 to Jan. 70	PREPARATION OF CONCEPT SKETCHES Program developed and some detail planning started. On the basis of research study, concept sketches prepared and presented.	3	Architect
Jan. 70	APPROVAL OF CONCEPT SKETCHES	1	Owner
Jan. 70 to Mar. 70	PREPARATION OF PRELIMINARIES Program confirmed and verified. Areas defined and sketch plans and outline specifications completed. Budget set.	3	Architect
Mar. 70 to Jul. 70	APPROVAL OF PRELIMINARIES	4	Owner
Jul. 70 to Sep. 70	PREPARATION OF TENDER DOCUMENTS Completion of detail drawings and specifications. Preparation of tender documents.	2	Architect
Sep. 70 to Oct. 70	APPROVAL TO CALL TENDERS	1	Owner

CHRONOLOGICAL PROCESS:

CASE STUDY NO. 4, p. 5

DATES	TASKS PERFORMED	TIME IN MONTHS	PERSONNEL INVOLVED
10 Oct. 70 to 12 Nov. 70	TENDER PERIOD - CONSTRUCTION Ten companies prepared tenders based on stipulated sum bids.	1	10 separate contractors
12 Nov. 70 to 01 Mar. 71	ANALYSIS OF BIDS AND CONTRACT AWARD (taking full 90 days).	3	Architect Owner
11 Mar. 71 to 30 Jun. 72	CONSTRUCTION Work in field carried out under control of general superintendent with very close quality supervision by architect.	15.5	Contractor Architect
24 Feb. 72 to 21 Mar. 72	TENDER PERIOD - FURNISHINGS AND EQUIPMENT Preparation of tenders based on architect's specifications.	1	Furnishing Contractors
30 Jun. 72 to 01 Dec. 72	FURNISH, EQUIP AND OCCUPY BUILDING Building furnished and equipped. Essential completion 13 Jul. 72.	6	Furnishing Contractors Architect Owner

TIME SCHEDULE

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
1969				1							2	
1970	3 4		5				6		7	8	9	
1971			10 11									
1972						12						13
1973												
1974												

1. 24 Apr. 69 - Appointment of Architect
2. 19 Nov. 69 - Presentation of research study
3. 12 Jan. 70 - Presentation of concept sketches
4. 30 Jan. 70 - Approval of concept sketches
5. 23 Mar. 70 - Presentation of preliminaries
6. 21 Jul. 70 - Approval of preliminaries
7. 15 Sep. 70 - Presentation of working drawings and specifications
8. 10 Oct. 70 - Request for tenders
9. 12 Nov. 70 - Receipt of tenders
10. 01 Mar. 71 - Contract signed
11. 11 Mar. 71 - Construction started
12. 30 Jun. 72 - Construction completed
13. 01 Dec. 72 - Occupancy by first resident

D.R.E.E. PROGRAM MANAGEMENT STUDY

CASE STUDY NO. 5 (CONSTRUCTION MANAGEMENT)

PROJECT DESCRIPTION

The building houses a University Educational Facility. Located in Ottawa it has a total gross floor area of 79,860 square feet on four floors, consisting of one below grade, a mezzanine at grade, and two upper levels of offices and lecture rooms. An auditorium, stage, kitchen and cafeteria are located on the first level. A library and reading area are on the first level and the mezzanine.

ORGANIZATION - CLIENT

The physical development of the university is managed by the Department of Planning and Construction. This department comes directly under the Director of Physical Plant who is responsible for planning, construction, maintenance and security of the university.

For a specific project, a users' sub-committee is formed to look into the details of the requirements and to produce a brief.

The brief outlines the facility and covers general requirements, giving approximate areas required for the individual functions. The brief is carefully written to give the architect a detailed picture of requirements without dictating the design. In some briefs the details of cash entitlement for the project and the anticipated cost per square foot are also given to enable the architect to design within a general financial framework.

The brief is submitted to the responsible provincial department for approval. On approval of the brief the architect is appointed

and integrated into the project management system. The architect is primarily responsible for designing the building in accordance with the brief and within the set budget.

The civic design of the university is handled by one town planning architect. Similarly civil engineering works, roads, site services, foot paths, etc. are designed by one consultant firm for the whole site. For the design of each individual building project, different architects are retained from the design stage to the completion of the project.

ORGANIZATION - PROJECT

A project management system was introduced to compress the overall planning and construction time and to provide an overall control of campus development. Each individual project is treated as an element of the whole program for campus development, rather than as a separate entity.

The Department of Planning and Construction acted as the program manager for the university and appointed various consultants to form a Management Team.

The Department of Planning and Construction selected the project manager from its own staff. The project manager controlled the overall project through project management meetings, held every second week, where all the consultants were represented. Any major decisions made at the design team meetings (see below) were briefly discussed for the approval of the project manager. Cost and time consultants reported directly to the project manager.

The team consisted of construction manager, (a contracting organization), architect, cost consultant, time consultant, structural, mechanical and electrical engineers, landscape architects, interior designer, civic design consultants and civil engineers. Team meetings, chaired by the construction manager, were held once a week where all consultants, representatives from the project manager's office and the users' sub-committee were represented. The prime function of the team was to coordinate the

design work by the various consultants and to work out design solutions. During the initial design period, a budget for individual elements was estimated and a close check kept on the overall project cost as the design phase progressed.

As the design of the project progressed, tenders were called by the construction manager for each completed trade section. The tenders were compared with the set budget and the contracts were let with modification if necessary. This organization is shown graphically in Schedule I.

CONTRACTUAL ARRANGEMENTS

The university signed contracts directly with all consultants, who were given a choice of percentage fee or per diem fee structure. Most of the consultants opted for per diem fee structure which was felt to be quite adequate. The architect, however, selected a straight percentage contract. During the construction phase, this allocated fee was felt to be inadequate as the demand on the architect's services increased to a greater extent. The architect's services during the construction phase included the supervision of the project, attendance on site and at design and project management meetings, plus keeping up with details and revised drawings and issuing requests for change orders.

The construction manager's contract with the university was on the basis of a percentage fee.

All sub-trade contracts were let directly with the university through the project manager: the construction manager was responsible for site supervision, scheduling and the preparation of progress payments for the approval of the project manager. There were odd jobs such as cleaning up, patching, etc. which could not be tendered adequately and the construction manager retained a labour force to carry these out. Requests for change orders originated from the consultants and were passed on to the construction manager who issued the change orders with co-signature of the project manager or his representative. Similarly, progress claims passed through the construction manager to the project manager who finally approved and forwarded certificates for payment.

Contractual relations are shown graphically in Schedule II.

CONTROL

Responsibility for cost and time control rested with the quantity surveyor and CPM consultant respectively, both reporting directly to the project manager. Quality control was exercised by the design team together with the project manager.

COMMENTS AND CONCLUSIONS

Comparing the roles played by the consultants and the sub-contractors in sequential/linear and project management systems, the main difference was felt to be in the appointment of the consultants. Most of the consultants preferred to be appointed direct by the client and to be responsible to the client rather than the architect. The team spirit approach to designing a building was a unique one and was most welcomed. The consultants generally were critical of the time spent in meetings. From the sub-contractors' point of view, apart from contractual relationships, there was little or no change from their traditional role. They preferred the sequential tendering system as they could quote for the job closer to its execution, which enabled them to be more competitive.

It would seem that consultants' fees on this project were somewhat above the normal percentage fee. The university feels that overall they received a better building, within the overall total project cost.

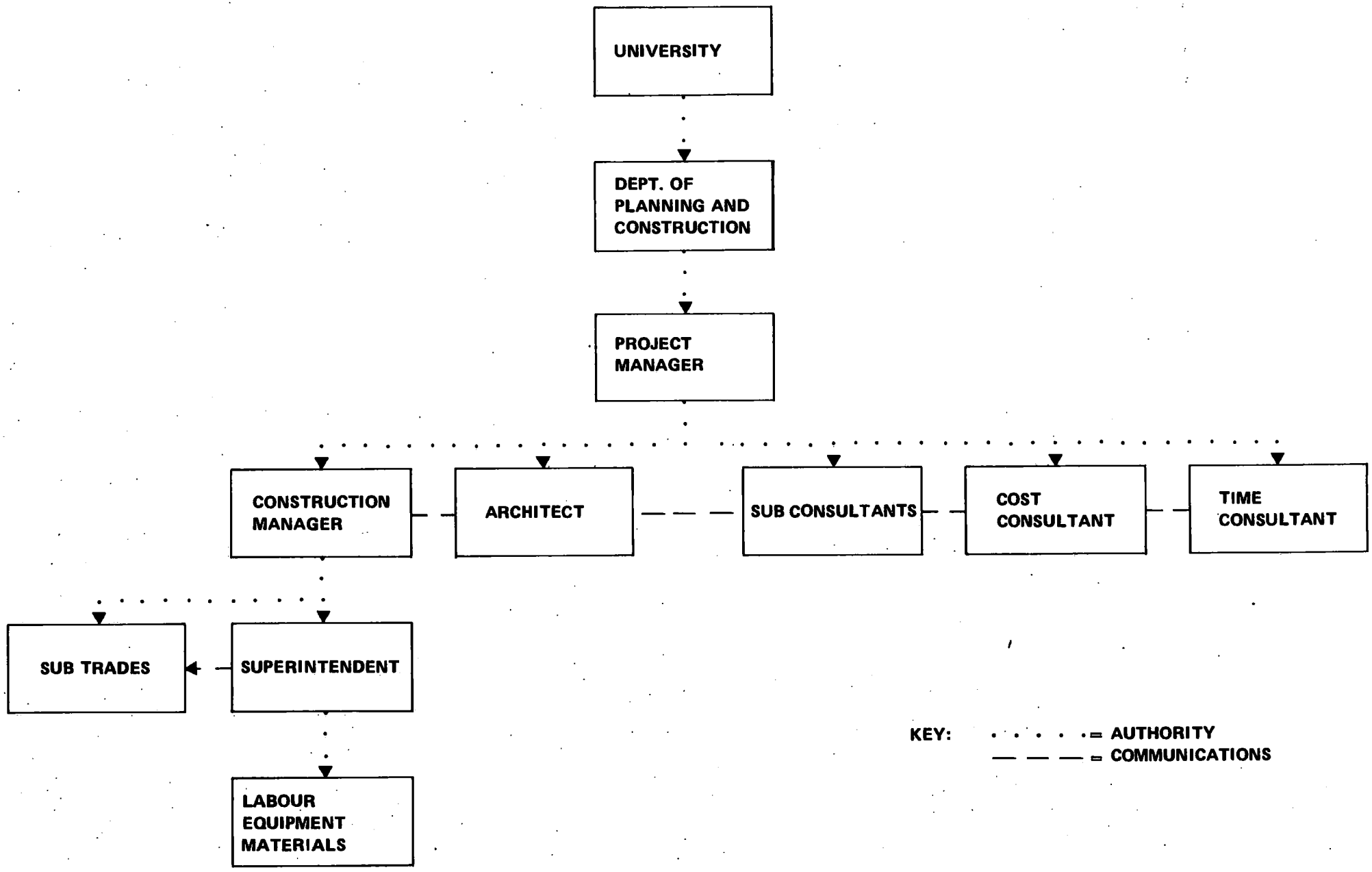
The system worked very well with the exception of some minor areas, changes for some of which are recommended below:

a) a clear definition of responsibilities, relationship and roles of consultants is required to avoid any misunderstanding;

b) the design team meetings were chaired by the construction manager and it is felt these would have been best chaired by the project manager's representative, keeping all the consultants on an equal basis;

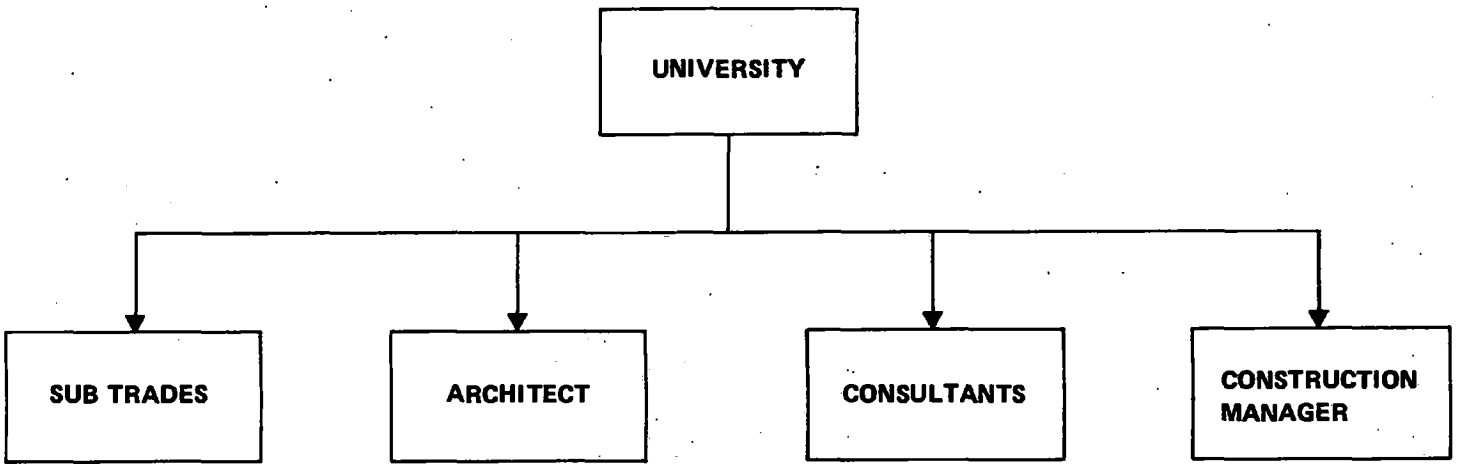
c) site accounting and paperwork should be drastically changed to give a better control over committed cost during the construction period. In this sytem an efficient cost control of the project is of prime importance because of the sequential tendering approach where the design, construction and tendering of various sections take place at the same time.

SCHEDULE I
MANAGEMENT ORGANIZATION



CASE STUDY NO. 5

SCHEDULE II
CONTRACTUAL ARRANGEMENTS



KEY: ———— =CONTRACTUAL LINK

CHRONOLOGICAL PROCESS:

CASE STUDY NO. 5, p. 6

DATES	TASKS PERFORMED	TIME IN MONTHS	PERSONNEL INVOLVED
May 72 to Jun. 72	APPOINTMENT OF TEAM, PREPARATION OF CONCEPT SKETCHES Program developed and some detail planning started. On the basis of preliminary studies, concept sketches prepared and presented.	2	Project manager Design team
Jun. 72 to Sep. 72	PREPARATION OF PRELIMINARY DRAWINGS Program confirmed and verified. Areas defined and sketch plans and outline specifications completed. Budget set.	4	Project manager Design team
Sep. 72 to Jan. 73	PREPARATION OF TENDER DOCUMENTS Completion of detail drawings and specifications. Preparation of tender documents.	5	Project manager Design team
Oct. 72 to Aug. 73	CONSTRUCTION Work in field carried out under control of superintendent with quality, cost, time control supervision by team.	11	Project manager Design team Trade contractors

TIME SCHEDULE

CASE STUDY NO. 5, p. 7

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
1968												
1969												
1970												
1971												
1972				1	2	3			4	5	6	
1973	7							8				

1. Apr. 72 - Inception of Project
2. May 72 - Appointment of Architect
3. Jun. 72 - Complete concept sketches
4. Sep. 72 - Complete preliminary drawings
5. Sep. 72 - Initial request for tenders
6. Oct. 72 - Construction start
7. Jan. 73 - Complete working drawings
8. Aug. 73 - Complete construction and initial occupancy

D.R.E.E. PROGRAM MANAGEMENT STUDY

CASE STUDY NO. 6 (CONSTRUCTION MANAGEMENT)

PROJECT DESCRIPTION

This project contained a mix of uses as tabulated below:

	Basement	Mezzanine	Main Floor	Upper Floor	Total
Retail	9,400		61,500		70,900
Community Club	8,800				8,800
Services	3,600		5,700	3,300	12,600
Circulation		600	600		1,200
Offices				21,300	21,300
Parking	23,000				23,000
	44,800	600	67,800	24,600	137,800

The building, located in Vancouver, had a total gross floor area of 137,800 square feet on three floors.

The building shape was irregular, the intent being to provide an interesting focal point for a residential development.

ORGANIZATION - CLIENT

The owner, a quasi-institutional organization, held land originally obtained for other, now redundant purposes, and set up a subsidiary

to develop the full potential of its holdings. This subsidiary has developed successfully and now actively seeks and buys land for development.

This subsidiary is structured in two divisions, namely, Operations and Projects. The former is by far the larger, administers a portfolio of existing buildings and actively acquires development properties. The latter is project oriented, handling new projects only. There appears to be cooperation and transfer of information between the divisions, albeit on an informal basis.

ORGANIZATION - PROJECT

The project division referred to above acted as project manager and carried out feasibility studies and initial programming with the assistance of independent consultants, including a construction company (general contractor). This team was under the direction of the project manager who made a presentation to the Board of Directors. This presentation included sketch plans, elevations, sections, a model and a budget. The Board of Directors gave a positive decision, after which the project was developed to a stage at which a guaranteed upset price could be sought. The project manager continued to control architectural design through a consultant architect, but delegated mechanical, electrical and structural design to the contractor. The responsibility for quality control rested with the project manager.

This organization is shown graphically in Schedule I.

CONTRACTUAL ARRANGEMENTS

The client had two major contracts: one with the contractor, the other with the architect. The latter contract was awarded first but did not contain all of the normal architectural services:

pre-planning and programming services were carried out on a per diem basis; actual preparation of production information (working drawings and specifications) for the architectural portion on a percentage basis. Post contract supervision as mentioned above was not required because the client organization had staff available to carry out this function. The general contractor who supplied input of an estimating nature at the program phase, technically free of charge, was awarded the contract for construction. All sub-contracts and engineering design contracts were awarded directly by the general contractor. Other sub-consultants were utilized - soils, market research, etc., on a direct fee basis with the owner.

Contractual relations are shown graphically in Schedule II.

CONTROL

The responsibility for cost, time and quality control rested with the owner's staff who tried to achieve a balance between the three. Initial budgeting was provided by the contractor who provided a chronological series of estimates. The contract between the owner and contractor provided for remuneration on a cost plus basis. As an incentive, a maximum upset amount was determined and the contractor contracted to receive 40% of savings below this figure. As mentioned above, the responsibility for control of quality rested with the client's project manager.

COMMENTS AND CONCLUSIONS

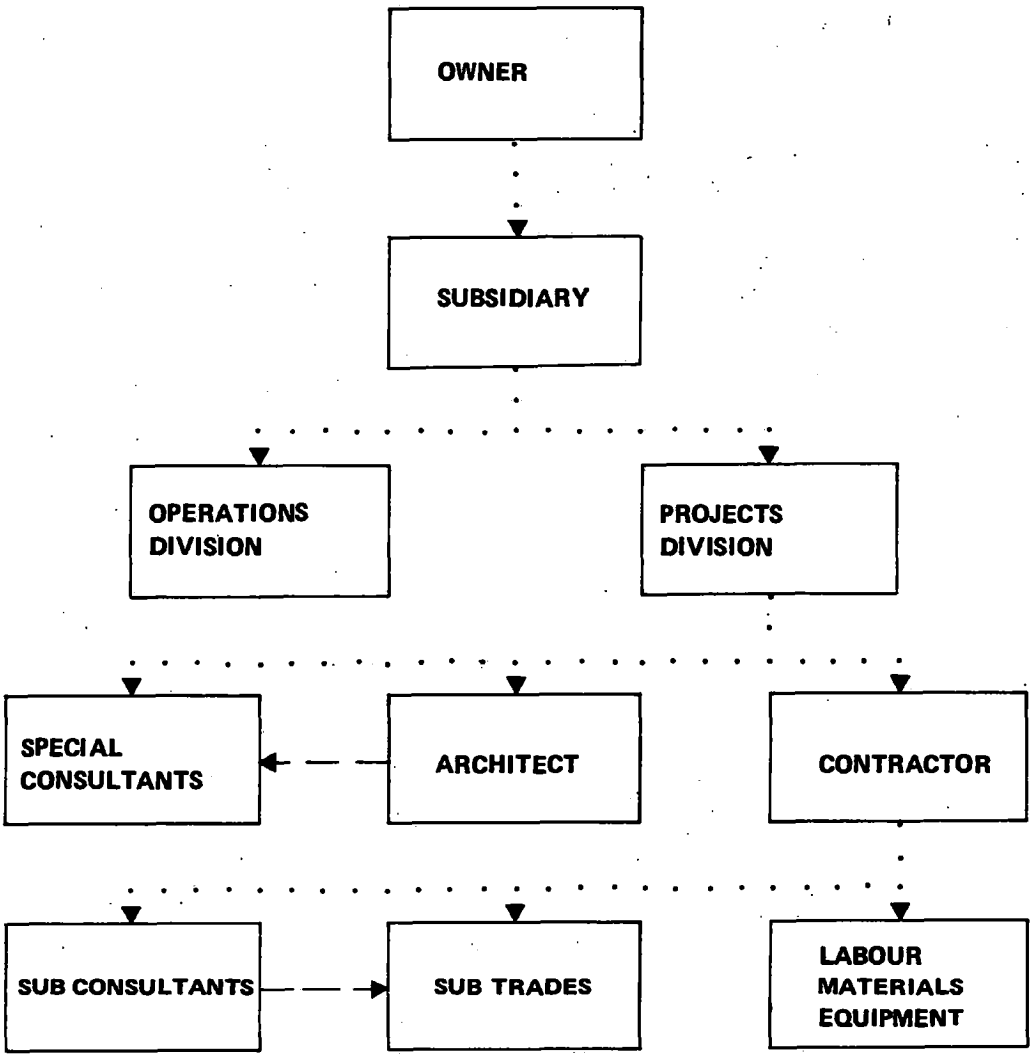
This project is an interesting hybrid as it cannot be classified properly in any of the three management systems. In that the general contractor hired the engineering design consultants, some elements of turnkey existed. However, the independent retention of an architect and design supervision by the owner suggests a

more traditional concept. The overall cooperation between the parties is commonly associated with construction management contracts. The resultant organization was achieved in an attempt to get the best of all of the systems. The client felt that whereas the approach used gave him better control of cost and time, aesthetic and "image" considerations were often ignored. He realized the possible problems inherent in his methods, the major one being to prevent the contractor from overstating costs at the estimating stage, thereby increasing his profit via the share of savings. To partially offset this, an independent quantity surveyor was hired to check the contractor's estimate. The contractor's lack of knowledge of sub-trade prices was evident in the conceptual phase.

At the time of writing the project was incomplete and therefore no conclusions regarding the success of the organization could properly be made.

CASE STUDY NO. 6

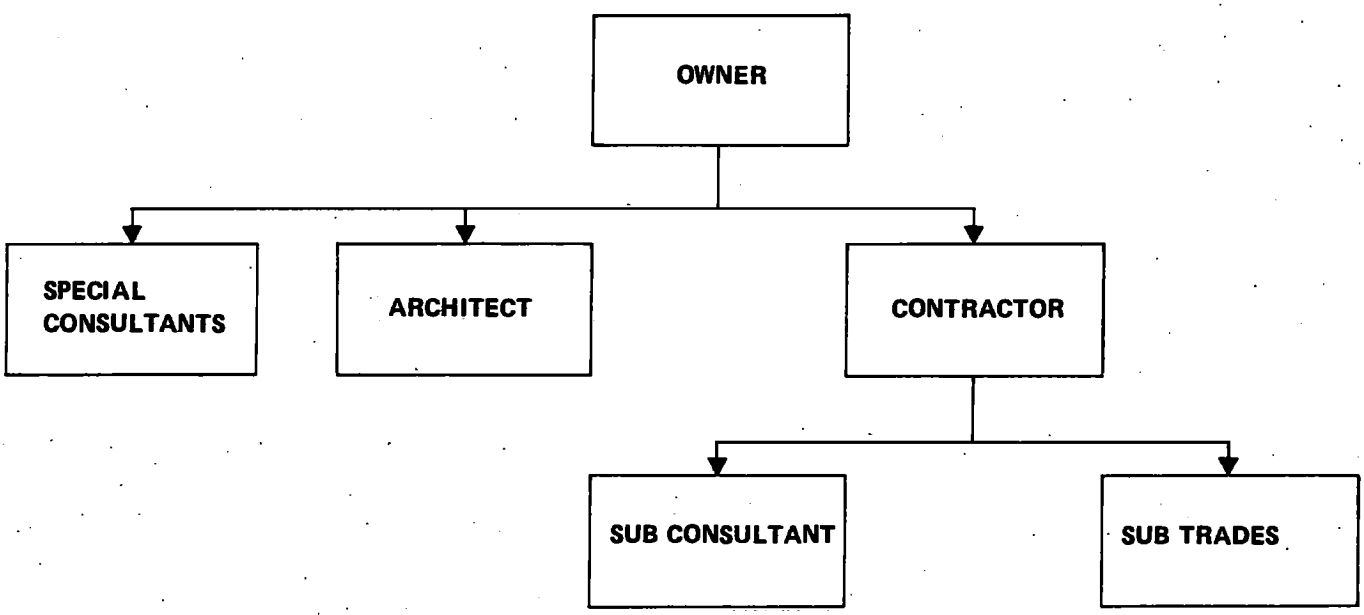
SCHEDULE I
MANAGEMENT ORGANIZATION



KEY: . . . . . = AUTHORITY
— — — = COMMUNICATIONS

CASE STUDY NO. 6

SCHEDULE II
CONTRACTUAL ARRANGEMENTS



KEY: ——— = CONTRACTUAL LINK

CHRONOLOGICAL PROCESS:

CASE STUDY NO. 6, p. 5

DATES	TASKS PERFORMED	TIME IN MONTHS	PERSONNEL INVOLVED
Jun. 72 to Oct. 72	FEASIBILITY STUDIES AND INITIAL PROGRAMMING Need recognized and analyzed. Program confirmed and verified. Areas defined, and sketch plans and outline specifications completed.	5	Owner's staff Consultants
Oct. 72 to May 73	PREPARATION OF TENDER DOCUMENTS Specifically for architectural portion; completion of detail drawings and specifications.	8	Owner's staff Consultants
May 73 to Jul. 73	TENDER PERIOD Tenders prepared consisting of outline design for remainder of building (mechanical, electrical, etc.). Estimates prepared and procurement process initiated.	3	Contractors
Jul. 73 to Aug. 73	ANALYSIS OF BIDS - SELECTION OF CONTRACTOR Bids analyzed on the basis of price, quality of proposal and capacity and reputation of bidder. Contract awarded.	1	Owner's staff
Aug. 73 to Dec. 74	PROCUREMENT PROCESS AND CONSTRUCTION Sub-trade design completed, tenders called and awarded as and when required. Quality, cost and time control carried out by owner.	16	Owner's staff Contractor and his design consultants

TIME SCHEDULE

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
1969												
1970												
1971												
1972						1				2		
1973					3		4	5				
1974												6

1. Jun. 72 - Project inception
2. Oct. 72 - Start production information
3. May 73 - Request for tenders
4. Jul. 73 - Receipt of tenders
5. Aug. 73 - Contract awarded, start of construction
6. Dec. 74 - Construction completed (projected)

appendices

GLOSSARY

Definition of terms is related to the context used in this report.

PROJECT	An undertaking resulting in a facility which responds to a given set of requirements.
PROJECT MANAGEMENT	The action involved in administering, coordinating and managing the planning, design and construction of facilities. The team acting under a project manager, responsible for the realization of the project.
PROJECT MANAGER	The leader of a project management team, with full authority over the project delivery, from inception to completion. Often used synonymously with "Project Coordinator".
PROGRAM	A plan of action fulfilling socio-economic needs through the development of required facilities.
PROGRAM MANAGEMENT	The action involved in planning and monitoring the realization of projects, and evaluating the performance of the facilities delivered, and the team responsible. Usually a committee or group formed from representatives of diverse agencies concerned with the implementation of a program.
PROGRAM IMPLEMENTATION	The conduct of a sequence of projects from inception, through utilization and evaluation.
PROJECT MONITORING	The process of supervision of the realization of a project and the measurement of its performance against the set requirements established by program management.

PROJECT COORDINATOR	The coordinator of the project management team which is acting within a program and which is accountable to Program Management for meeting the performance requirements. (See also "Project Manager".)
PROJECT ADMINISTRATOR	Refer "Project Manager" and "Project Coordinator".
CONSTRUCTION MANAGER	A general contractor or independent consultant acting as a professional in assuming responsibility for procurement and realization of construction. The role often involves some control over design in whole or in part.
SYSTEM	A set of elements whose attributes are interrelated.
MANAGEMENT SYSTEM	A set of persons or agencies whose roles interrelate for the achievement of a project, using defined procedural forms.
CLIENT	The person or organization that initiates the project.
SPONSOR	Part of the client organization that allocates the financial resources to the project.
USER	The agency or organization that requires the facility for continued use.
CONSULTANT	A person or agency, hired on a fee basis, to provide professional advice to the client or his representative.
CONTRACTOR	An enterprise that enters into a contract to construct and deliver a facility.

SUPPLIERS	Manufacturers and/or sales enterprises that supply the materials, components and pieces of equipment necessary for construction.
LUMP SUM CONTRACT	A contractual agreement between the client organization and the contractor based on a total fixed amount for the construction and delivery of a facility.
COST PLUS CONTRACT	A contractual agreement between the client organization and the contractor based on the actual cost of construction and delivery plus an agreed margin or fee for the contractor.
STIPULATED SUM CONTRACT	See "lump sum contract".
PROJECT MANAGEMENT SYSTEM	The set relationship instituted by contract or practice between the members of the project team. Three basic families of Project Management Systems identified are: Sequential/ linear; Construction Management; Turnkey.
FAST-TRACKING	An approach to the procurement of a facility where the design and construction stages are tendered by sections in order that they can partially overlap and allow compression of time. Sometimes called parallel tendering.
PARALLEL TENDERING	See "fast-tracking".
DESIGN-BUILD	See "Turnkey".
SEQUENTIAL/ LINEAR	Project management system in which the traditional client-consultant-contractor-supplier linear type of relationship prevails and in which actions are generally conducted sequentially.

CONSTRUCTION MANAGEMENT	Any project management arrangement involving partial or full control over design by a construction manager.
TURNKEY	Project management system in which the client, on the basis of specifications, contracts out both the design and construction of the project to a single independent organization.

ACQUISITION	The act of producing a building, or a facility, to satisfy given user needs and requirements.
PROCUREMENT	The act of purchasing the necessary inputs for the implementation of a building or facility program.

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Construction Management (CM):	1, 11, 18, 21, 22, 25, 33, 42, 49, 58, 59
Costs and Cost Control:	3, 25, 37, 43, 50, 59, 64
Education:	62
Government:	23, 58
Management - General:	14, 19, 38, 39, 40, 47, 57
Management - Research and Development:	38
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LEGAL CONSIDERATIONS APPLICABLE TO DIFFERENT MANAGEMENT SYSTEMS

The primary consideration in all instances must be the terms of the contract between the various parties engaged in any construction project. Although there may well have been a time when a construction project was a summary matter and the rights of the parties was determined by some custom developed over the years, the nature of the industry has now changed to the point where any reliance upon such custom to determine the rights as between the parties is dangerous at best. In any project of any consequence the definition of the rights and obligations of the various parties one to another should be set forth as clearly and completely as possible. The form and content of construction contracts has become increasingly more important with the added size of projects and the larger number of persons who become involved. It is therefore of primary importance regardless of the type of arrangement into which the parties believe they are entering that they read, understand and comply with the terms of the contract documents which are eventually executed between them.

In all of the management systems which have been discussed the work which has to be performed to bring the project to completion is the same. The distinction in the various systems is found in the division of responsibility for accomplishing the various phases of the work and, ancillary to that, the division of the authority which is necessary to allow those responsibilities to be discharged. It is the nature of the division of these responsibilities and authority that must be appreciated to afford anyone an understanding of the legal distinctions between the systems.

Parties to a contract can agree to assume any obligation they wish. A court in interpreting an agreement is not bound nor is it inclined to assist a party to an agreement to escape a responsibility which that party has clearly undertaken, no matter how onerous it may be. As a general rule however what makes good sense makes good law. Thus where a court is attempting to interpret an agreement between parties to determine what their

responsibilities and rights are, it will attempt to read the entire agreement so as to make it consistent one part with the other and to define the positions of the parties in a manner consistent with what a reasonable person could have been anticipated to have agreed. This is not to mean that if the clear words of the agreement demonstrate that one of the parties has agreed to something which seems unreasonable then he will be relieved from it; if however, the two parties to an agreement contend for opposite interpretations of its terms and one interpretation appears reasonable and the other unreasonable in the light of common business practice and what a reasonable man could be expected to do, a court is more inclined to accept the reasonable interpretation if it is consistent with the wording of the agreement.

Although there has been a discussion of three distinct management systems, these systems certainly are not exhaustive of those which are employed in the construction industry. By the same token, in practice they are not always totally distinct in the sense that one would conceive of them in theoretical terms. There can be a partial blending of the various types of systems by a distribution of responsibilities and authorities between the parties which is somewhat different from the normal form as set out below. To appreciate the significance of the distinctions from a legal point of view however, there are certain broad concepts which are consistent with the various management systems which should be considered.

SEQUENTIAL/LINEAR

In all instances one must keep in mind that the difference in the systems is in the distribution of the responsibilities for performing all of the work that is necessary to complete a project.

In the more traditional form of undertaking involving a general contractor the owner who is the party which determines the distribution of the responsibilities, places the entire responsibility for the construction of the project on the general contractor. It is then the obligation of the general contractor to arrange for the provision of the materials and labour necessary for the construction of the building or other work as described in his contract. The owner is required in such a contract with a general contractor to set forth all of his requirements in regard to the project. In general terms the contract should provide some basis for how and under what circumstances the owner shall discharge its obligation, which is to make payment and how and under what circumstances the contractor will be deemed to have fulfilled his obligation which is to build a project as described in his contract. In this regard there should be a provision as to the time within which the work will be done, what will be deemed to be an acceptable quality of the final product, who is to be the judge as to whether or not the quality has been attained, at what times and in what amounts the contractor shall be paid and under what circumstances the owner is entitled to take over the work.

As the owner must provide an adequate description of the project which he wishes completed the responsibility for the design must then be delegated to other persons, normally architects and consulting engineers. There may be some instances in which the owner feels competent to adequately describe the project to be undertaken by the general contractor but this is certainly not the norm. There is nothing about this arrangement however that requires that the owner retain architects and consultants but the expertise of those professions has largely mitigated against any other approach to the completion of that phase of the work.

In light of the expertise of architects and consultants the responsibility for insuring that their design is properly followed in the construction is generally accepted by the consultants. If

in fact the owner is looking to the consultants to perform this function it must be spelled out both in the architect's and the engineer's contracts and in the general contractor's contract. This is necessary in order that the general contractor can be forced not only to allow the consultants to attend on the job site to make their inspections but also in order that he could be bound by their judgments reasonably arrived at.

Under this type of system the owner should by his contracts be in a position where he has:

a) delegated the responsibility for the production of a workable design to the architect and consulting engineers;

b) delegated the responsibility for construction of the project to the general contractor;

c) delegated the responsibility for inspection to ensure that the project complies with the design to the architects and consultants.

CONSTRUCTION MANAGEMENT

The relationships which exist when a construction manager is employed differ somewhat conceptually from those where a general contractor is involved. In essence, the owner under this relationship becomes his own general contractor and hires an expert in the construction industry to act on his behalf in discharging many of the functions which would normally be undertaken by a project manager on the staff of a general contractor.

The owner through the construction manager plays a larger role in the development of the design and the contracts between the owners and consultants should reflect the role which the construction manager will play without relieving the consultants from their responsibility for the final design within the limits of the directions given by the owner or the construction manager acting for the owner.

The owner through the construction manager enters into contracts with the various trades in much the same manner as a general contractor would. The arrangement between the owner and the various contractors with whom he contracts is very similar to that between an owner and a general contractor to the extent that all of the rights and obligations as between the parties are generally set forth in a contract. It becomes readily apparent that one of the risks inherent in this type of arrangement is that the sum total of the contracts let will not encompass all of the work. Another matter of some great concern is that the contracts entered into with the various trades are consistent one with another so that the authority given to the various parties to discharge the responsibility they undertake is not superseded or in conflict with the authority given to another party. This is of paramount importance as a contractor who is not given the unrestricted power to complete his work has a valid basis for complaint.

The responsibilities assumed by the owner vis-a-vis the consultants and trade contractors is in theory discharged by the construction manager acting for and with the owner. The owner is entitled to look to the construction manager to provide the judgment and knowledge

necessary to allow the owner to proceed in this type of arrangement. Should the construction manager not provide this service with the degree of diligence and competence which should be displayed by one in that profession, the consequences of the failure could rest with the construction manager.

The construction manager is an agent of the owner and to the extent that the owner does not publicly restrict his authority he can through his actions bind the owner in his dealings with the various contractors who are engaged for the project and possibly even with the consultants. This is so in spite of the fact that the construction manager may have a much more restricted authority to act on behalf of the owner under the terms of the contract between the owner and the construction manager. The construction manager and the owner should both be very much concerned that they understand the scope of the authority which is given to the construction manager and the role that he is to play in binding the owner.

The relationship which develops between an owner and a construction manager varies from one project to another. Whereas in some instances the owner is almost totally divorced from the job and in effect allows the construction manager to operate with an unfettered discretion, in other instances the owner takes a very active and visible role in the course of the project. From a construction manager's point of view the matter which is of essence is that he be allowed to perform his job. The only interference which can prevail is that from the owner and in a construction manager's contract, it is important to ensure that since he is selling his expertise, that he is at least given enough authority to bring his expertise to bear and have some control over the eventual outcome of the project.

The other matter of concern to the relationship in this type of arrangement is the position of the construction manager in relation to the other consultants retained. A construction manager although he may well be an engineer or an architect is not generally selling an expertise in those fields and although he might be involved with the consultants in the design and be advising the owner in this regard, it should as well be made clear in his contract that the final responsibility for the design rests with those consultants who are retained for that purpose.

TURNKEY

In a turnkey operation, once again the same work has to be performed and the nature of the contracts entered into between the various parties relates only to the altered division of the responsibility for undertaking the various tasks necessary to achieve the completion of the project. The nature of the relationship which is somewhat unique from the other systems discussed is that between the owner and the company which undertakes to provide the installation. The contract between these parties must set forth all the requirements of the owner. The contractor must then produce a project which meets those requirements. This type of contract is possibly the most difficult for anyone to prepare as the description of the owner's requirements must, of necessity, be in fairly broad terms and once agreed to cannot be expanded upon by the owner. It is of crucial importance that the owner and contractor in this type of relationship define their understanding of the project which is to be undertaken in the clearest possible terms as the failure to do so will very likely lead to disputes and additional cost at a later date.

The concept of this arrangement, however, is that the owner having initially described his requirements can then look to the contractor to arrange for the design and construction of a building which falls within those requirements and the full risk of achieving this then rests with the contractor. The only obligation of the owner remains to make payment in accordance with the terms of the agreement. The contractor in this type of arrangement having entered into an agreement with an owner then assumes the position of an owner and may proceed with the project in any manner it deems best.

CONCLUSION

As has been set forth above, the distinction between the relationships in the eyes of the law rests really with the division of the responsibilities and this can only be determined by a reading of the contractual documents. In all instances it is essential that the various contracts entered into by the parties are consistent one with the other. The agreements should have the effect of apportioning all of the work which is necessary to bring the project to a completion and should as well define the authority which each party has so that there is not a conflict between them.

In view of the fact that the relationship between the parties is actually defined by the contracts it is important to realize that attaching a label to the scheme of management which is to be adopted for a particular project can have no effect whatsoever in face of agreements between parties which do not reflect that relationship.