THE BUILDING CONTRACTOR AND PROJECT CONTROL: CASE STUDIES

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ABSTRACT

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This report documents the second part of a multi-phase research programme which is aimed at the development of management information systems for the building contractor to support the functions of project planning, scheduling and control, estimating, multi-project control, accounting, payroll and equipment management.

This study provides a description of the building contractor with respect to the problem of project planning and control with emphasis on the latter. Detailed case studies of three successful Montreal-based general contracting firms engaged in building construction are presented and characteristics of their organization are explored. Emphasis is placed on management practices with respect to single project planning and control, roles of management personnel and information transfer for purposes of project control. Also provided is a framework for research on the design and development of contractor Management Information System in which key MIS variables and parameters describing each variable are identified. Where possible, the implications of these parameters with respect to the design of MIS for individual project control are noted.

ACKNOWLEDGEMENTS

I wish to express my gratitude to the individuals whose assistance and encouragement were instrumental in the realization of this thesis.

Firstly, I wish to thank my thesis supervisor, Dr. Alan D. Russell, for his guidance, insight and dedication throughout my research.

I am grateful to the building contractors (whose identification is withheld for the sake of confidentiality), for providing the information without which the case study process would not have succeeded. The openness and cooperation of the individuals interviewed was most appreciated.

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A special thanks is extended to my wife, Luisa, for her encouragement, patience and psychological support, and to her sister, Brenda, for her valuable editorial assistance.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

1.1 INTRODUCTION

This report documents the second part of a multi-phase research programme which is aimed at the development of management information systems for the building contractor to support the functions of project planning, scheduling and control, estimating, multi-project control, accounting, payroll and equipment management. The essential goal is to design these information systems so that they

(i) optimize the use of information presently available to the firm;

(ii) are compatible with the manner in which the firm operates and with the skills of existing personnel;

(iii) report the correct and necessary information in a form which can best be interpreted by management and at a level of detail most appropriate for the individual managers and/or supervisory personnel who will be using this information;

(iv) get this information to its various users both at the time required and frequency required; and

(v) enhance interdepartmental and interpersonal communications and business relationships with external parties such as the firm's clients, banker, surety as well as suppliers and subcontractors.

For purposes of this report, a management information system (MIS) is defined as a system for collecting, sorting, retrieving and processing information which is used or desired by one or more managers in the performance of their duties. The need for such a system in building construction has been documented by Revay (19) and Kirittopoulos (16).

The first part of this research programme (16) focused on the need for collecting, analyzing and reporting information for use by the contractor's clients, bank and surety. One of the recommendations of this study was that a more detailed understanding of the structure of building contracting firms be developed. It is the purpose of this present study to help develop such an understanding.

1.2 THESIS OBJECTIVES

From the research documented to date (refer to Chapter 2), a framework for the development of MIS for the building contractor has yet to be identified. This identification task must include the formulation of a model of the firm which reveals its crucial variables and the range of values they can assume. However in defining a model of the firm one is faced with the difficult task of working, not with mathematical variables, but rather with man-made systems for which models must be hypothesized and then proved or disproved by empirical studies.

Mason and Mitroff (17) identified the key variables comprising an MIS by proposing that "an information system consists of at least one PERSON of a certain PSYCHOLOGICAL TYPE who faces a PROBLEM within some ORGANIZATIONAL CONTEXT for which he needs some EVIDENCE to arrive at a solution and that evidence is made available through some MODE OF PRESENTATION". As discussed in Chapter 2, this description of an MIS provides a useful framework for tackling the task of developing information systems that are matched to the building contractor's needs and capabilities. Essential to this description and framework is a model of the firm.

The goal of this thesis is to provide a description of the building contractor with respect to the problem of project planning and control, with emphasis on control, by way of presenting case studies of three successful Montreal based general contracting firms engaged in building construction. The specific thesis objectives are:

1. To provide a framework for research for the design and development of contractor MIS by identifying key MIS variables and parameters describing each variable and to identify knowledge gaps in the literature with respect to the building contractor and the design of MIS for his use (Chapter 2);
2. To conduct detailed case studies of three firms to explore their characteristics with respect to the PROBLEM of project planning and control with emphasis on control (Chapters 3, 4, and 5);

3. To suggest guidelines for further work directed at MIS (Chapter 6).

1.3 METHODOLOGY

The methodology employed to achieve the thesis goals consisted of a combination of literature review and interviewing of contractors with the aid of a series of questionnaires (Appendix I). The literature search was used to assist in the formulation of a framework for analysis. A literature survey was also conducted to identify the needs of the building contractor. However it was discovered that the literature in the area of construction management largely focuses on heavy engineering contractors, the nature of whose work is quite different than that of the building contractor.

A set of detailed interviews was conducted with personnel of three firms. An incomplete series of interviews were also held with two individuals from two other firms. The information obtained was consistent with that obtained from the detailed interviews. It was deemed important to conduct interviews rather than just sending questionnaires since, this way, the questions could be rephrased if required so as to apply directly to each firm, thus adding more flexibility and greater depth to the process and information obtained.

In an interview with a leading figure of the Canadian Construction Association well known for his role in the development of the Canadian construction industry, the following question was asked: "What do you see an institution such as ours doing in the way of applied research to help building contractors?" He responded: "I think the answer to that would be to continue to do just what you are doing right now, in interviews such as this. I am perhaps a little critical about some of your questions because I find them a little on the academic side. If your research leads more to the practical side of construction - that is the practical aspects of the construction process and the practical aspects of administration of a construction company - then you will be contributing a great deal to the industry".

The reader must note that statistically the sample size is very small; consequently it carries a low level of confidence for being representative of the whole industry. However, great depth is required if one is to formulate an accurate model of the firm.

The major contribution of this thesis is seen to lie in the development of a deeper understanding of the anatomy of the firm, thereby giving future researchers benchmarks for their work and a means for tailoring existing work performed for large heavy engineering firms to the needs of the building contractor. A contribution also lies in the application of an existing MIS framework to the problem of planning and control for the general building contractor.

1.4 SOME CANADIAN BUILDING CONSTRUCTION STATISTICS

The goal of this section is to examine the volume of construction work and related trends over the past 15 years by making use of statistical information available from Statistics Canada. The purpose is to identify the audience in most need of help.

1.4.1 Overall Statistics

Construction volumes have increased significantly from 1962 to 1977 both in nominal and in real terms. Table 1.1 illustrates the total output of construction work in Canada both in current and in constant 1971 dollars. The total volume of construction work has increased from $7,343 million in 1962 to $35,753 million in 1977. This represents an increase of 387 percent. In constant dollars the increase during the same period is from $11,295 million to $19,101 million which represents an increase of 69 percent. For building construction the value of work in constant dollars in 1962 was $6,634 million and in 1977 it reached $10,825 million, showing a real growth of 63 percent. This growth is made up of 105 percent in residential construction and 27 percent in non-residential construction. Figure 1.1 and Figure 1.2 further describe the growth in construction during this period in current and constant dollars respectively.

If one focuses on the province of Quebec, similar trends are observed. Table 1.2 illustrates the output of construction activity both in current and constant 1971 dollars. While the value of total construction has shown a nominal increase of 379 percent and a real increase of 59 percent, the real increase in residential construction is 70 percent and in non-residential construction only 21 percent. Figures 1.3 and 1.4 further describe the growth in construction during this period in current and constant dollars respectively.

From these figures it may be concluded that:

1. engineering construction seems to be the sector with the steadiest increase both in all of Canada as well as in Quebec alone;
2. building construction is more unstable;
3. the rate of growth of non-residential building construction is much lower than other sectors. In fact since 1975 it has shown a decline in the rate of growth; this decline is even more pronounced in Quebec.

1.4.2 Non-Residential Building Construction Statistics

Statistics Canada divides non-residential building construction into four categories; these are, industrial, commercial, institutional and other buildings. Appendix III identifies the types of buildings in each of these categories. Table 1.3 and Figures 1.5 and 1.6 illustrate the growth since 1962 in construction for each of these categories in Canada in current and constant dollars. The category that shows the highest volume is commercial building construction. This category also shows the most rapid growth from 1962 to 1975 going from $1,053 million to $2,497 million, as well as the sharpest decrease from 1975 to the 1977 figure of $1,954 million.

Examining similar statistics for Quebec which are illustrated in Table 1.4 and Figures 1.7 and 1.8 the trends are similar. In the commercial category, the real value of construction work done in 1962 was $339 million; in 1975 this reached $866 million, which represents an increase of 155 percent. However in 1977 that figure fell to $462 million, representing a decrease of 47 percent in only two years.

From the statistics on non-residential construction the following conclusions may be drawn:

1. Long-range predictions on the trends of non-residential construction are extremely difficult to make, thus posing major problems for the strategic planning process of construction firms.
2. The decline in volume of work since 1975 has greatly increased competition amongst contractors thus decreasing profit margins and increasing the potential for failure. To survive, firms must place greater emphasis on project planning and control.

1.5 TARGET AUDIENCE

In examining the present situation in the construction industry from the statistical data available, it may be concluded that attention of those engaged in construction research should be focussed on the non-residential building contractor. Furthermore, from Table 1.5, it is clear that the low profit margins of the non-residential building contractors do not permit the firms to allocate large sums of money to undertake research.

This thesis focuses on the general building contractor in non-residential construction. Firms that belong to this category are grouped according to their yearly volume of work. These groups are as follows:

1. firms whose yearly volume is between 0 and \$500,000
2. firms whose yearly volume is between \$500,000 and \$2 million
3. firms whose yearly volume is in excess of \$2 million.

Table 1.6 and Table 1.7 illustrate the number of contractors belonging to each group each year from 1971 to 1976 in Canada and in Quebec respectively. Table 1.8 and Table 1.9 illustrate the value of work performed by the firms belonging to each of these groups in Canada and in Quebec respectively. From these statistics the following conclusions may be drawn:

1. The number of contractors whose yearly volume is in excess of \$2 million has increased from 1971 to 1976. In 1976, 28 percent of the firms in non-residential construction in Canada and 33 percent of those in Quebec were in this category.
2. The volume of work performed by firms whose yearly volume is

in excess of $2 million consists of 82 percent of the volume of work by the non-residential building contractors in Canada and of 80 percent of the volume of work by those in Quebec.

Thus the target audience for this thesis is further refined to include only the non-residential building contractor whose yearly volume is in excess of $2 million.

YEAR	TOTAL CONSTRUCTION WORK			BUILDING CONSTR.		RESIDENTIAL CONSTR.			NON-RESIDENTIAL CONSTR.		
	CURRENT $ x 10^6	CONSTANT 1971 $ x 10^6	CONSTANT$ / CURRENT$	CURRENT $ x 10^6	CONSTANT 1971 $ x 10^6	CURRENT $ x 10^6	CONSTANT 1971 $ x 10^6	CONSTANT$ / CURRENT$	CURRENT $ x 10^6	CONSTANT 1971 $ x 10^6	CONSTANT$ / CURRENT$
1962	7343	11295	1.538	4543	6634	2100	3062	1.458	2443	3572	1.462
1963	7716	11491	1.489	4692	6683	2257	3220	1.427	2435	3463	1.422
1964	8663	12410	1.433	5179	7134	2605	3569	1.370	2574	3565	1.385
1965	9928	13391	1.349	5906	7702	2752	3564	1.295	3154	4138	1.312
1966	11237	14202	1.264	6661	8186	2873	3496	1.217	3788	4690	1.238
1967	11621	13806	1.188	6826	7994	3065	3522	1.149	3761	4472	1.189
1968	12214	14524	1.189	7258	8406	3587	4082	1.138	3671	4324	1.178
1969	13207	14801	1.121	8055	8863	4228	4592	1.086	3827	4271	1.116
1970	13781	14711	1.067	8098	8605	4009	4262	1.063	4089	4343	1.062
1971	15865	15865	1.0	9367	9367	4976	4976	1.0	4391	4391	1.0
1972	17289	16353	0.946	10328	9761	5871	5536	0.943	4457	4225	0.948
1973	20174	17369	0.861	12405	10374	7165	5789	0.808	5240	4585	0.875
1974	24693	17870	0.724	15245	10815	8461	5720	0.676	6784	5095	0.751
1975	28376	18278	0.644	16609	10477	8690	5179	0.596	7919	5298	0.669
1976	33131	19230	0.580	20472	11434	12669	6651	0.525	7803	4783	0.613
1977	35753	19101	0.534	20942	10825	12951	6294	0.486	7991	4531	0.567
1978	37865			21656		13584			8072		

1977 - preliminary actual
1978 - intentions

SOURCE: Statistics Canada Cat. No. 64-201 and 64-502

TABLE 1.1 VALUE OF CONSTRUCTION WORK PERFORMED IN CANADA

YEAR	TOTAL CONSTRUCTION WORK			BUILDING CONSTR.		RESIDENTIAL CONSTR.			NON-RESIDENTIAL CONSTR.		
	CURRENT $ x 10^6	CONSTANT 1971 $ x 10^6	CONSTANT$ / CURRENT$	CURRENT $ x 10^6	CONSTANT 1971 $ x 10^6	CURRENT $ x 10^6	CONSTANT 1971 $ x 10^6	CONSTANT$ / CURRENT$	CURRENT $ x 10^6	CONSTANT 1971 $ x 10^6	CONSTANT$ / CURRENT$
1962	1891	2908	1.538	1241	1812	598	872	1.458	643	940	1.462
1963	1964	2924	1.489	1266	1803	649	926	1.427	617	877	1.422
1964	2366	3390	1.433	1411	1944	705	966	1.370	706	978	1.385
1965	2617	3530	1.349	1580	2060	733	949	1.295	847	1111	1.312
1966	2689	3399	1.264	1663	2043	725	882	1.217	938	1161	1.238
1967	2543	3021	1.188	1597	1869	763	877	1.149	834	992	1.189
1968	2552	3034	1.189	1621	1878	795	905	1.138	826	973	1.178
1969	2696	3022	1.121	1725	1898	887	963	1.086	838	935	1.116
1970	2789	2976	1.067	1760	1870	870	925	1.063	890	945	1.062
1971	3412	3412	1.0	2091	2090	1070	1070	1.0	1020	1020	1.0
1972	3745	3543	0.946	2294	2168	1205	1136	0.943	1089	1032	0.948
1973	4373	3765	0.861	2760	2319	1432	1157	0.808	1328	1162	0.875
1974	5598	4053	0.724	3734	2664	1869	1263	0.676	1865	1401	0.751
1975	7111	4579	0.644	4472	2844	2017	1202	0.596	2455	1642	0.669
1976	7903	4583	0.580	5127	2885	2930	1538	0.525	2197	1347	0.613
1977	8677	4634	0.534	5064	2624	3055	1485	0.486	2009	1139	0.567
1978	9059			4803		2991			1812		

1977 - preliminary actual
1978 - intentions

SOURCE: Statistics Canada Cat. No. 64-201 and 64-502

TABLE 1.2 VALUE OF CONSTRUCTION WORK PERFORMED IN QUEBEC

YEAR	INDUSTRIAL		COMMERCIAL		INSTITUTIONAL		OTHER BUILDINGS		
	CURRENT $ x 10^6	CONSTANT 1971 $ x 10^6	CURRENT $ x 10^6	CONSTANT 1971 $ x 10^6	CURRENT $ x 10^6	CONSTANT 1971 $ x 10^6	CURRENT $ x 10^6	CONSTANT 1971 $ x 10^6	CURRENT / CONSTANT
1962	492	719	720	1053	827	1209	405	592	1.462
1963	536	762	737	1048	857	1219	306	435	1.422
1964	666	922	846	1172	765	1060	297	411	1.385
1965	775	1017	1015	1332	1019	1337	344	451	1.312
1966	1001	1239	1250	1548	1171	1450	397	491	1.238
1967	870	1034	1221	1452	1258	1496	412	490	1.189
1968	744	876	1146	1350	1379	1624	402	474	1.178
1969	869	970	1152	1286	1335	1490	472	527	1.116
1970	1000	1062	1287	1367	1330	1413	473	502	1.062
1971	1023	1023	1405	1405	1456	1456	507	507	1.0
1972	927	879	1706	1617	1249	1184	575	545	0.948
1973	1149	1005	2212	1936	1200	1050	680	595	0.875
1974	1532	1151	2969	2230	1383	1039	900	676	0.751
1975	1510	1010	3732	2497	1561	1044	1117	747	0.669
1976	1450	889	3628	2224	1594	977	1130	693	0.613
1977	1652	937	3446	1954	1663	943	1230	697	0.567
1978	1479		3555		1719		1319		

1977 - preliminary actual
1978 - intentions

SOURCE: Statistics Canada Cat. No. 64-201 and 64-502

TABLE 1.3 VALUE OF NON-RESIDENTIAL CONSTRUCTION WORK PERFORMED IN CANADA

YEAR	INDUSTRIAL		COMMERCIAL		INSTITUTIONAL		OTHER BUILDINGS		CURRENT/CONSTANT
	CURRENT $ x 10^6	CONSTANT 1971 $ x 10^6	CURRENT $ x 10^6	CONSTANT 1971 $ x 10^6	CURRENT $ x 10^6	CONSTANT 1971 $ x 10^6	CURRENT $ x 10^6	CONSTANT 1971 $ x 10^6	
1962	119	174	232	339	211	308	81	118	1.462
1963	123	175	207	294	225	320	60	85	1.422
1964	142	197	238	330	244	338	103	143	1.385
1965	182	239	292	383	298	391	75	98	1.312
1966	207	256	375	464	260	322	95	118	1.238
1967	186	221	290	345	256	304	102	121	1.189
1968	171	201	247	291	324	382	85	100	1.178
1969	176	196	218	243	331	369	113	126	1.116
1970	161	171	249	264	367	390	114	121	1.062
1971	226	226	253	253	422	422	119	119	1.0
1972	256	243	344	326	344	326	145	137	0.948
1973	360	315	454	397	335	293	179	157	0.875
1974	482	362	782	587	364	273	237	178	0.751
1975	466	312	1294	866	378	253	319	213	0.669
1976	456	280	1082	663	401	246	259	159	0.613
1977	485	275	814	462	435	247	275	156	0.567
1978	379		719		428		285		

1977 - preliminary actual
1978 - intentions

SOURCE: Statistics Canada Cat. No. 64-201 and 64-502

TABLE 1.4 VALUE OF NON-RESIDENTIAL CONSTRUCTION WORK PERFORMED IN QUEBEC

YEAR	NET OPERATING PROFIT (LOSS) BEFORE TAX / TOTAL OPERATING REVENUE							
	FOR ALL FIRMS		FIRMS WHOSE YEARLY VOLUME IS BETWEEN 0-$500,000		FIRMS WHOSE YEARLY VOLUME IS BETWEEN $500,000-$2 MILLION		FIRMS WHOSE YEARLY VOLUME IS BETWEEN $2 MILLION & OVER	
	(%)	NO. OF FIRMS REPORTING	(%)	NO. OF FIRMS REPORTING	(%)	NO. OF FIRMS REPORTING	(%)	NO. OF FIRMS REPORTING
1971	1.5	1170	2.1	794	1.4	295	1.5	81
1972	1.8	1400	2.3	869	1.7	386	1.5	145
1973	1.7	1425	3.3	818	1.8	441	1.3	166
1974	2.3	1313	3.3	710	2.7	424	2.0	179
1975	3.0	889	-	-	3.8	479	2.8	410
1976	2.5	911	-	-	3.3	475	2.3	436

SOURCE: Statistics Canada Cat. No. 64-207

TABLE 1.5 NET OPERATING PROFIT AS A PERCENTAGE OF TOTAL OPERATING REVENUE

YEAR	TOTAL NUMBER OF FIRMS	FIRMS WITH YEARLY VOLUME OF 0-$500,000		FIRMS WITH YEARLY VOLUME OF $500,000-$2 MILLION		FIRMS WITH YEARLY VOLUME OF $2 MILLION AND UP	
		NUMBER	% OF TOTAL FIRMS	NUMBER	% OF TOTAL FIRMS	NUMBER	% OF TOTAL FIRMS
1971	1901	1352	71	434	23	114	06
1972	1815	1279	70	415	23	125	07
1973	1798	1196	67	469	26	133	07
1974	1567	976	62	485	31	168	11
1975	1519	494	33	583	38	442	29
1976	1629	503	31	585	36	449	28

SOURCE: Statistics Canada Cat. No. 64-207

TABLE 1.6 TOTAL NUMBER OF NON-RESIDENTIAL CONTRACTORS IN CANADA CLASSIFIED BY SIZE

YEAR	TOTAL NUMBER OF FIRMS	FIRMS WITH YEARLY VOLUME OF 0-$500,000		FIRMS WITH YEARLY VOLUME OF $500,000-$2 MILLION		FIRMS WITH YEARLY VOLUME OF $2 MILLION AND UP	
		NUMBER	% OF TOTAL FIRMS	NUMBER	% OF TOTAL FIRMS	NUMBER	% OF TOTAL FIRMS
1971	402	267	66	112	28	23	06
1972	382	240	63	110	29	32	08
1973	386	237	61	115	30	34	09
1974	333	190	57	108	32	39	12
1975	339	86	25	143	42	110	32
1976	337	78	23	144	43	111	33

SOURCE: Statistics Canada Cat. No. 64-207

TABLE 1.7 TOTAL NUMBER OF NON-RESIDENTIAL CONTRACTORS IN QUEBEC CLASSIFIED BY SIZE

YEAR	TOTAL CONSTR. OUTPUT CURRENT $ x 10^6	CONSTRUCTION OUTPUT BY CONTRACTOR WHOSE YEARLY VOLUME IS BETWEEN					
		0 - $500,000		$500,000 - $2 MILLION		$2 MILLION - OVER	
		CURRENT $	% OF TOTAL	CURRENT $	% OF TOTAL	CURRENT $	% OF TOTAL
1971	2773	482	17	990	36	1301	47
1972	2776	492	18	964	35	1320	47
1973	2889	454	16	988	34	1447	50
1974	3414	387	11	1050	31	1977	58
1975	4036	68	02	628	16	3340	82
1976	3974	95	02	621	16	3258	82

SOURCE: Statistics Canada Cat. No. 64-207

TABLE 1.8 VALUE OF NON-RESIDENTIAL CONSTRUCTION WORK PERFORMED IN CANADA BY CONTRACTORS OF DIFFERENT SIZES

YEAR	TOTAL CONSTR. OUTPUT CURRENT $ x10^6	CONSTRUCTION OUTPUT BY CONTRACTOR WHOSE YEARLY VOLUME IS BETWEEN					
		0 - $500,000		$500,000 - $2 MILLION		$2 MILLION - OVER	
		CURRENT $	% OF TOTAL	CURRENT $	% OF TOTAL	CURRENT $	% OF TOTAL
1971	634	109	16	275	44	250	40
1972	621	104	17	263	42	254	41
1973	653	95	15	242	37	316	48
1974	758	81	11	260	34	417	55
1975	976	12	01	154	16	810	83
1976	865	16	02	154	18	695	80

SOURCE: Statistics Canada Cat. No. 64-207

TABLE 1.9 VALUE OF NON-RESIDENTIAL CONSTRUCTION WORK PERFORMED IN QUEBEC BY CONTRACTORS OF DIFFERENT SIZES

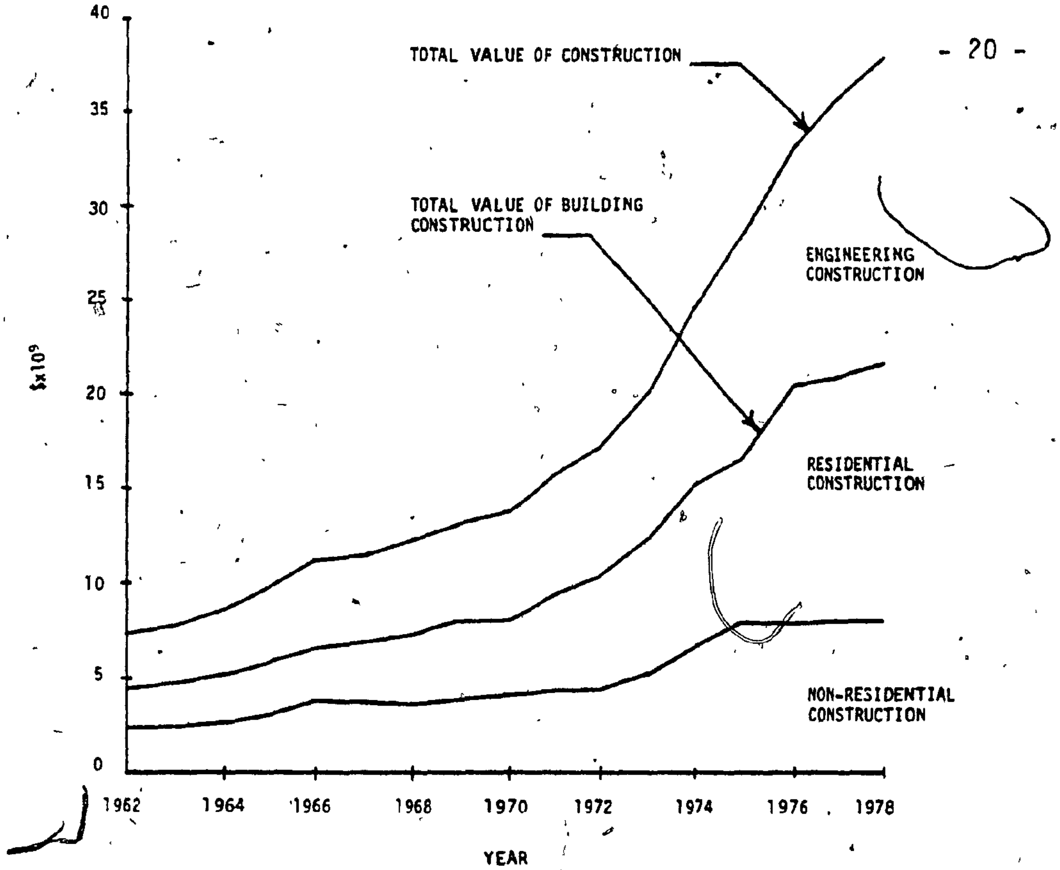


FIGURE 1.1 - VALUE OF CONSTRUCTION WORK IN CANADA
(CURRENT DOLLARS)
SOURCE: TABLE 1.1

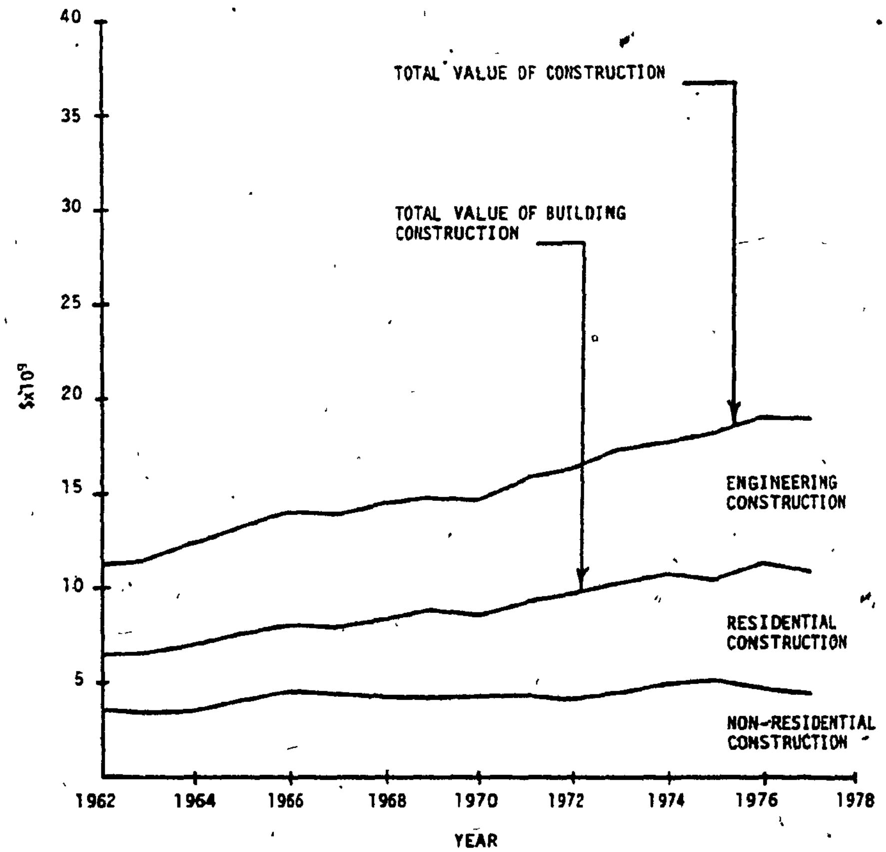


FIGURE 1.2 - VALUE OF CONSTRUCTION WORK IN CANADA
(CONSTANT 1971 DOLLARS)
SOURCE: TABLE 1.1

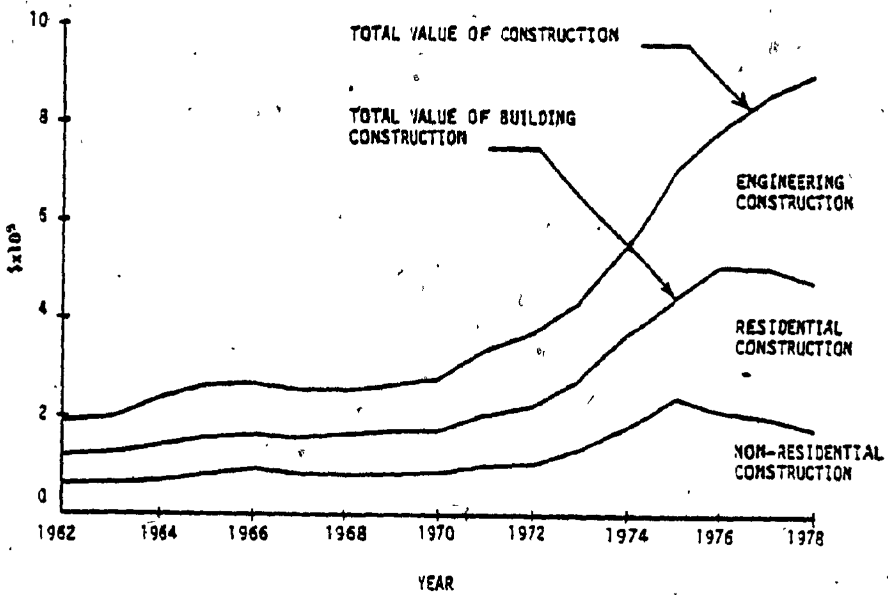


FIGURE 1.3 - VALUE OF CONSTRUCTION WORK IN QUEBEC
(CURRENT DOLLARS)
SOURCE: TABLE 1.2

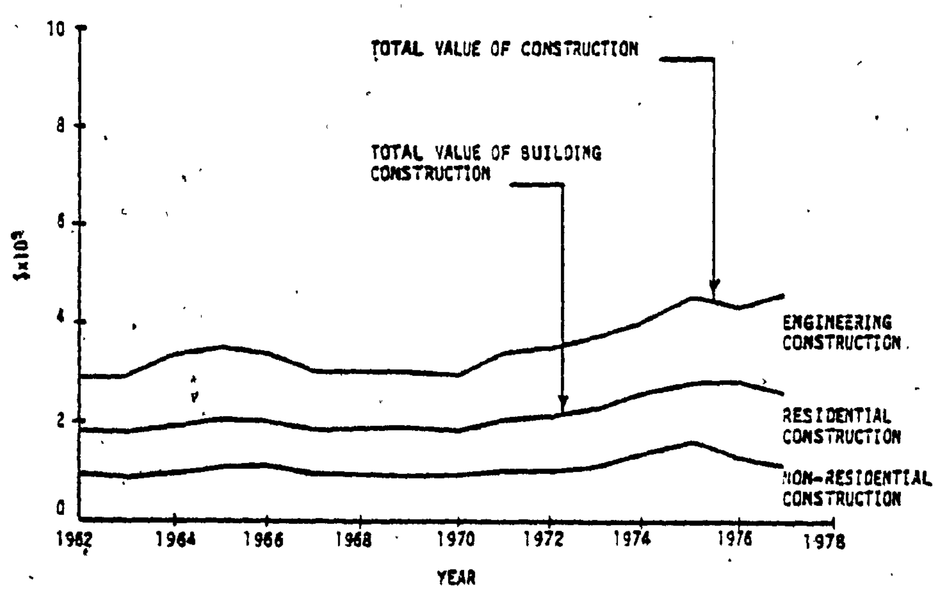


FIGURE 1.4 - VALUE OF CONSTRUCTION WORK IN QUEBEC
(CONSTANT 1971 DOLLARS)
SOURCE: TABLE 1.2

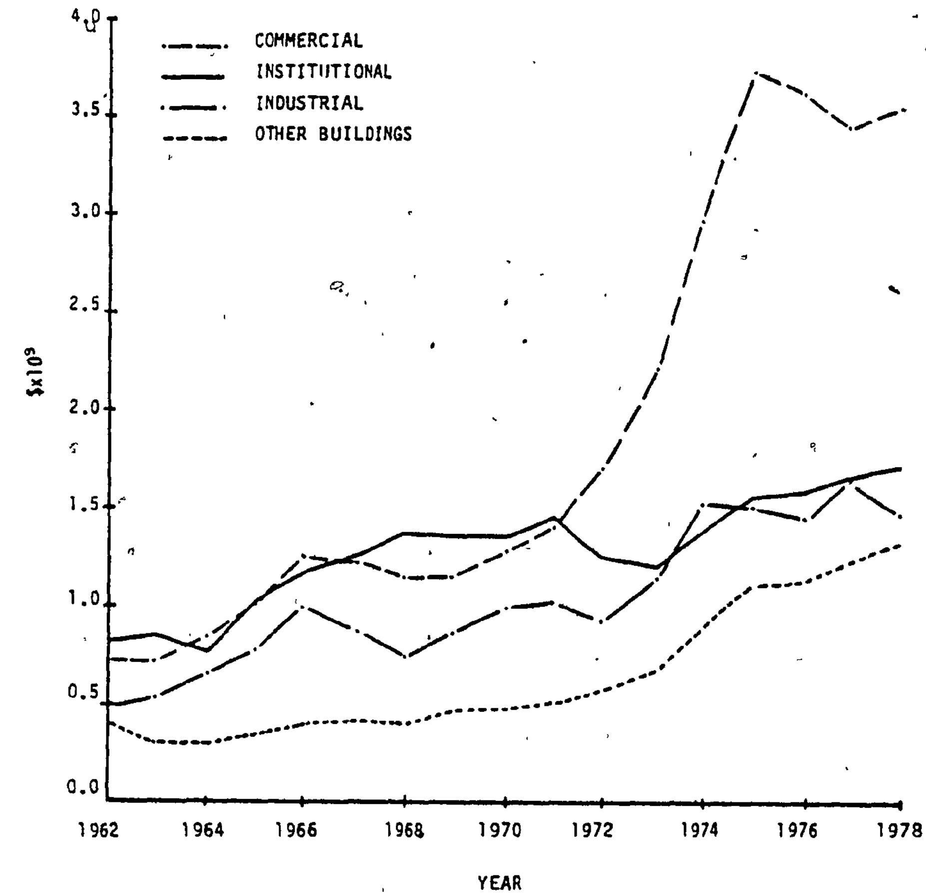


FIGURE 1.5 - VALUE OF NON-RESIDENTIAL CONSTRUCTION WORK IN CANADA (CURRENT DOLLARS)
SOURCE: TABLE 1.3

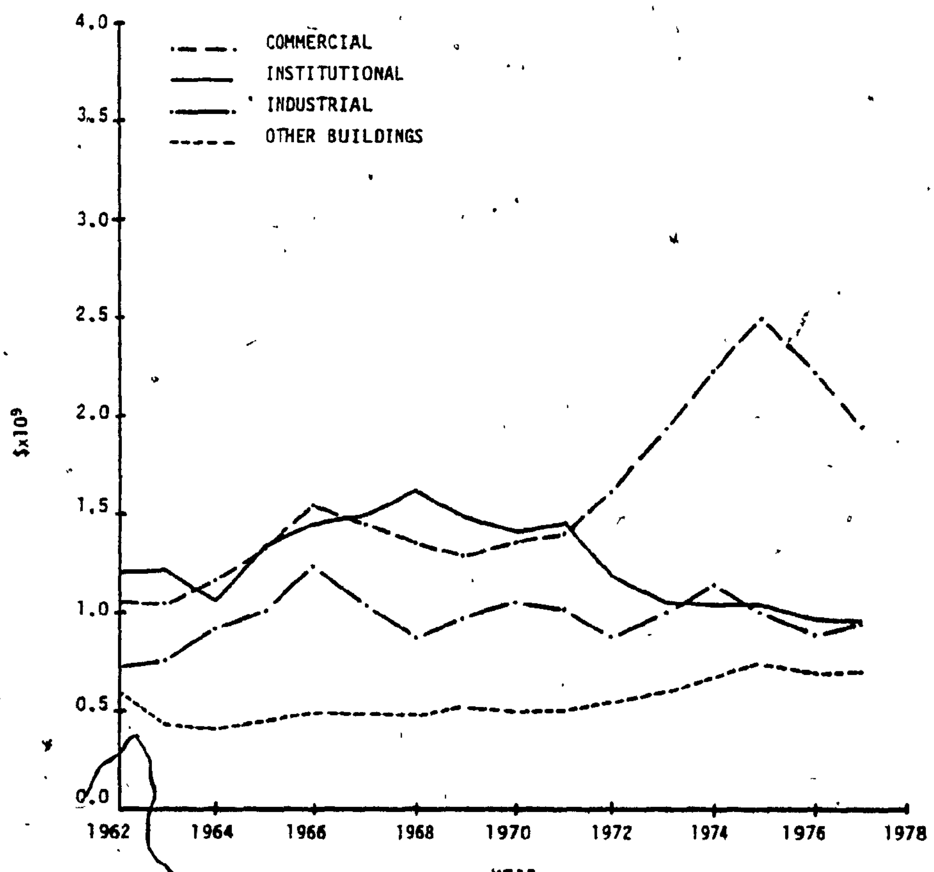


FIGURE 1.6 - VALUE OF NON-RESIDENTIAL CONSTRUCTION WORK IN CANADA (CONSTANT 1971 DOLLARS)
SOURCE: TABLE 1.3

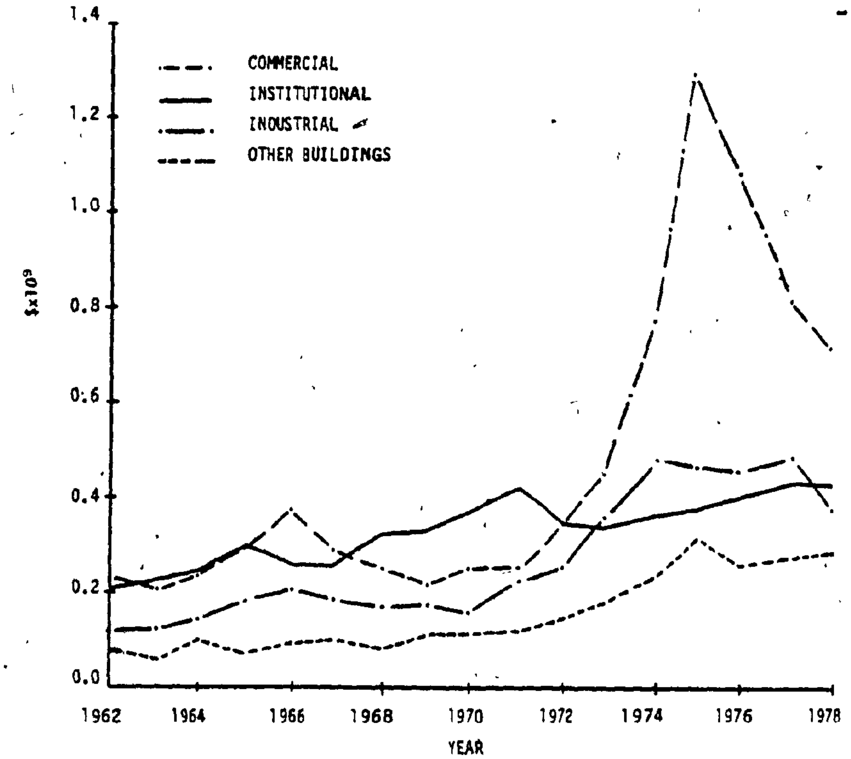


FIGURE 1.7 - VALUE OF NON-RESIDENTIAL CONSTRUCTION WORK IN QUEBEC (CURRENT DOLLARS)

SOURCE: TABLE 1.4

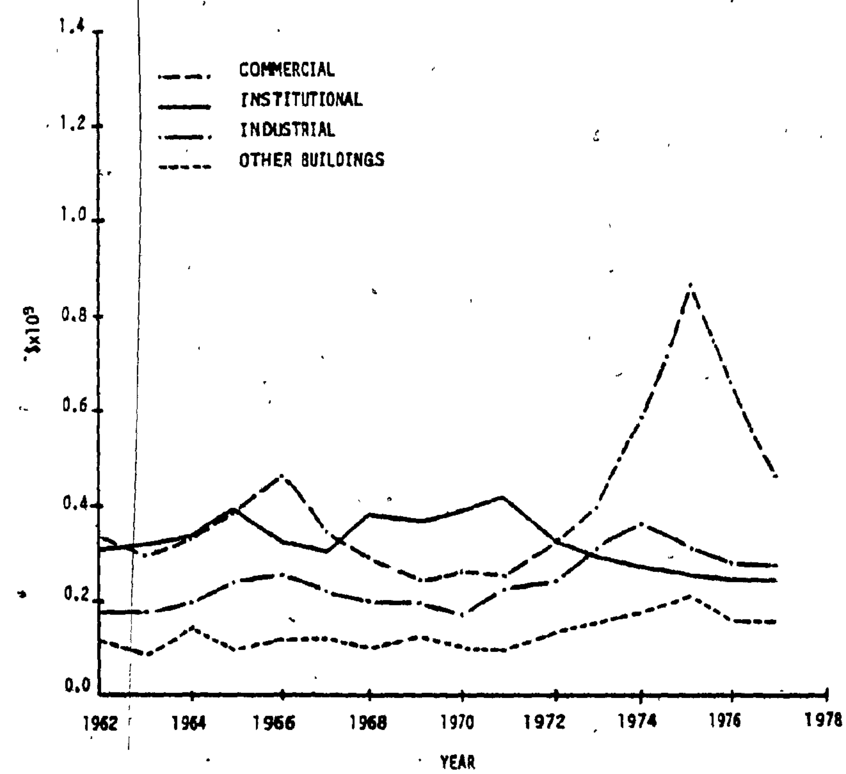


FIGURE 1.8 - VALUE OF NON-RESIDENTIAL CONSTRUCTION WORK IN QUEBEC (CONSTANT 1971 DOLLARS)

SOURCE: TABLE 1.4

CHAPTER 2

2.1 INTRODUCTION

As stated in Chapter 1, there is a need for a framework for tackling the task of developing project management information systems (PMIS) that are matched to the building contractor's needs and capabilities. To date, such a framework has not been set forth in the construction management literature and indeed a text on management information systems for construction has yet to be written.

A framework is needed because it allows for effective organization of knowledge available pertaining to MIS design and because it helps in identifying assumptions made by MIS designers. This latter point is especially important. To date, many implicit assumptions have been made by MIS designers with respect to contractors. Some of these assumptions are: construction personnel possess medium to high quantitative skills and prefer to work in a quantitative way; vast amounts of data from the field are available; the user possesses knowledge of how to use the information output from the MIS to take effective action; and information needs are at best marginally dependent on project type and mode of delivery. In fact, many of these assumptions are inaccurate with respect to the general building contractor. The lack of success experienced by many contractors with computerized MIS may be attributed, in large part to these erroneous assumptions.

The objectives of this chapter are:

(i) To provide a framework for research on the design and development of contractor PMIS by identifying key MIS variables and parameters describing each variable; and

(ii) To identify knowledge gaps in the literature with respect to the building contractor and the design of MIS for his use.

The framework adopted herein was first proposed by Mason and Mitroff (17). They suggested that "an information system consists of at least one PERSON of a certain PSYCHOLOGICAL TYPE who faces a PROBLEM within some ORGANIZATIONAL CONTEXT for which he needs some EVIDENCE to arrive at a solution and that evidence is made available through some MODE OF PRESENTATION."

Considerable consensus has developed in the management science literature regarding the usefulness of the Mason-Mitroff framework. Subsequent work by other authors has been directed at exploring each of the variables, mostly in the context of large manufacturing firms.

An attempt will be made herein to provide a useful definition of the key variables, first by starting with the Mason-Mitroff definition of each and then by tailoring it to account for the context of construction planning and control. A framework for analysis for each of these variables will also be proposed by identifying parameters that characterize each variable. When possible, general examples will be given of the implications that specific parameter values might have for MIS design. The key variables are highly interactive and this interaction can be identified, in part, by way of the same parameter being used to describe more than one variable.

The methodology employed consists of a literature survey and a preliminary analysis of the case studies presented in Chapters 3 through 5. No attempt is made at completeness in either the literature search or in the task of identifying parameters describing each variable. A more extensive search is required and an evaluation of the significance of the various parameters identified is left for future work. It is clear from the search conducted, however, that many theoretical issues with respect to the six key variables are still outstanding. As well, the construction literature relating to contractor MIS is highly fragmented and contains many gaps. This latter discovery provided the primary motivation for undertaking extensive case studies.

Of importance to the technical development of an MIS is whether it will be manual or computer based, and if the latter, the nature of the machine environment. Over the last decade, rapid technological progress has occurred in the field of powerful, low cost minicomputers and small business machines. The ability to have these machines in house and accessible on a schedule determined by the user makes their purchase or lease potentially attractive to the contractor. Their development is leading to a resurgence of interest in computers on the part of the contractor.

While the results of this thesis should prove useful to the development of minicomputer based PMIS, the development of such software is beyond its scope. A report by Riaz (21) describes several commercially available minicomputer hardware and software systems available for contractor use.

For purposes of logical presentation, discussion of the key variables is presented in the following order and groupings: (i) PROBLEM; (ii) ORGANIZATIONAL CONTEXT; (iii) PEOPLE AND PSYCHOLOGICAL TYPE; and (iv) EVIDENCE and MODE OF PRESENTATION.

2.2 PROBLEM

Mason and Mitroff discuss the variable PROBLEM in terms of the classical decision analysis problem (18). A decision problem is defined as consisting of a decision maker D who must select an alternative or course of action A_i; from a set of actions $A_1 \ldots A_m$ such that some return function U_{ij} is optimized, where U_{ij} is the value or utility to D of the outcome O_{ij} resulting from the choice of A_i and the occurrence of the state of nature S_j, where S_j is the set of states of nature. They suggest that a decision problem may be classified into one of two categories. The first category is that of structured problems, of which there are three kinds.

(i) Decision problem under certainty

The sets $[A_i]$, $[U_{ij}]$, $[O_{ij}]$, and $[S_j]$ are all known and there is a known relationship between A_i and O_{ij} given S_j.

(ii) Decision problem under risk

The sets $[A_i]$, $[U_{ij}]$, $[O_{ij}]$ and $[S_j]$ are all known and there is a known probabilistic relation between A_i and O_{ij} given S_j described by the set $[P_{ij}]$.

(iii) Decision problem under uncertainty

The same as (ii) except that $[P_{ij}]$ is not known.

Unstructured or "wicked" decision problems exist when one or more of the $[A_i]$, $[U_{ij}]$, $[O_{ij}]$, and $[S_j]$ terms or sets is totally unknown or not known with any high degree of confidence.

In practice, of the two problem categories, one is more likely to encounter wicked decision problems. They are not well defined. They are difficult to measure (i.e. are characterized by many criteria) such that one course of action can be described in terms of good, bad or reasonable with respect to another although such rankings might differ between informed decision makers. Finally, the selection of a course of action is usually governed by the finite resources and time available - thus one seeks a satisfying as opposed to an optimal solution.

While the foregoing description on the variable PROBLEM is descriptive of many of the decisions encountered in project planning and control, an operational definition is sought. Consequently one is provided as follows.

The task of project planning and control involves the application of a CONTROL SYSTEM so as to meet the time, cost and content objectives of a specific PROJECT which must be built within a particular ENVIRONMENT.

2.2.1 Problem Variable - Project

The variable PROJECT may be described by a set of attributes as shown in Table 2.1. Attention is restricted to building projects. In some cases examples are given of possible implications for the project planning and control function and design of a supporting PMIS. It should be noted that most, if not all, of the attributes cited are beyond the control of the general contractor. The impact of project type and characteristics on the development of effective control systems has yet to be fully explored in the literature.

2.2.2 Problem Variable - Environment

Interaction of the variable ENVIRONMENT with the PROJECT variable constitutes the source of the problems encountered in the control phase of a project. This variable may be described by attributes such as weather, project location with respect to head office, labour, materials and equipment supply, client, architect-engineer, foundation conditions, etc. A more extensive listing of attributes may be found in Appendix IV in which two questionnaires designed to identify causes for project delay and cost overruns are presented. These questionnaires are currently being completed by the contractors interviewed for the case studies. The delay questionnaire is patterned after one presented in reference 4. A questionnaire of a similar nature should be developed on problems encountered with project quality control. Most of the items identified in the questionnaires, while having a significant impact on project objectives, are beyond the direct control of the contractor.

2.2.3 Problem Variable - Control System

The variable CONTROL SYSTEM is viewed as being comprised of PEOPLE, TECHNIQUES, PROBLEMS, an INFORMATION SYSTEM, CONTROL VARIABLES and MANAGEMENT ACTION. All of these variables are highly interrelated.

The variable PEOPLE is described in the sections dealing with the Mason Mitroff variables ORGANIZATIONAL CONTEXT (section 2.3) and PERSON and PSYCHOLOGICAL TYPE (section 2.4). Issues treated include various levels of management personnel, their roles and responsibilities, skills, experience, motivation and preferred modes of decision-making.

The variable TECHNIQUES has been treated extensively in the literature (1) (2) (3) and deals with network based methods such as CPM, PERT, time cost tradeoff analysis, resource leveling and allocation; simulation; decision analysis; forecasting etc. While many contractors claim that such techniques are too sophisticated for their needs and incompatible with the skills of their personnel, they still must obtain by some means much of the output information that such techniques provide.

2.2.3.1 Control System Variable - Problems

The variable PROBLEMS is usefully described by the Mason

Mitroff description of the variable PROBLEM. Simply stated, these problems related to determining how to most effectively meet the time, cost, and content objectives of the project, how to assess if they are being met and how to determine what action(s) to take to solve problems arising from interaction of the variables PROJECT and ENVIRONMENT. Decision problems may be viewed as structured or unstructured (14). Following the work of Simon (24) and Gorry and Scott Morton (14), the phases of a decision problem may be described as intelligence, design and choice. If explicit models can be formulated for all three phases, then a problem is considered to be structured and can be delegated to a machine. A semi-structured problem exists when at least one phase can be modeled while an unstructured problem exists when all three phases can not be explicitly modeled. A key ingredient to the tackling of semi and unstructured problems is the formulation of the problem by the decision-maker.

Prior to developing an information system, models of the problems to be supported by the system must be formulated if a proper assessment is to be made of the information required and the value of information. To date, considerable progress has been made in the formulation of explicit models for the planning phase and the progress is reflected in the variable TECHNIQUES. Much less success has been achieved at formulating problems in the control phase largely because of their non-routine nature and organization, project and environment dependence.

2.2.3.2 Control System Variable - Information Systems

The purpose of an INFORMATION SYSTEM is to support the managerial activities of the decision-maker. For structured routine problems, the system should be capable of selecting the most appropriate course of action. For non-structured problems, the system should be able to assist in educating the decision-maker as to the potential outcome given his selection of a course of action. An information system may be viewed as consisting of both FORMAL and INFORMAL parts. The formal part of the system consists of written, quantifiable information which may be manipulated and processed using various TECHNIQUES or models. The informal part of the system consists of undocumented, qualitative information which is communicated orally and processed by undocumented and imperfectly understood mental processes. This latter aspect of an information system is very prevalent with building contractors and in many cases predominates over the formal aspect. Attention is directed here at formal information systems, the need for which was identified in Chapter 1. Barrie and Paulson (5) stated the following objectives for a PMIS.

1. To provide an organized and efficient means of measuring, collecting, verifying, and quantifying data reflecting the progress and status of operations on the project with respect to schedule, cost, resources, procurement, and quality.
2. To provide standards against which to measure or compare

progress and status. Examples of standards include CPM schedules, control budgets, procurement schedules, quality control specifications, and construction working drawings.

3. To provide an organized, accurate, and efficient means of converting the data from the operations into information. The information system should be realistic and should recognize (a) the means of processing the information (e.g. manual versus computer), (b) the skills available, and (c) the value of the information compared with the cost of obtaining it.

4. To report the correct and necessary information in a form which can best be interpreted by management, and at a level of detail most appropriate for the individual managers or supervisors who will be using it.

5. To identify and isolate the most important and critical information for a given situation, and to get it to the correct managers and supervisors, that is, those in a position to make best use of it.

6. To deliver the information to them in time for consideration and decision making so that, if necessary, corrective action may be taken on those operations that generated the data in the first place.

A flow chart of a project control system based on the these objectives was suggested by the authors and is depicted in Figure 2.1. A detailed explanation of the various elements of this flow chart may be found in reference 5. Of importance to note here is that this control system reflects the needs of a medium to large engineering project being delivered by way of a project management procurement mode in which key office and field staff personnel are professional engineers. Consequently this system description reflects one USER or PERSON type, one particular ORGANIZATIONAL CONTEXT, and one PROJECT TYPE, all of which differ from those of the thesis target audience. While many of the basic principles of a control system as depicted in Figure 2.1 are equally applicable to all types of construction, their operational aspects can be highly dependent on the foregoing variables. Thus one might expect significant differences between the features of a control system for a non-residential building contractor and a heavy engineering contractor engaged say in power projects.

As derived from Figure 2.1, the main variables describing a project management information system are items 4, 5, 6 and 7 - i.e. MONITORING and MEASURING PROGRESS, STANDARDS FOR COMPARISON, INFORMATION PROCESSING SYSTEM and REPORTS and UPDATES. The first and last of these variables correspond to the Mason-Mitroff variables EVIDENCE and MODE OF PRESENTATION (Section 2.5).

The existence of useful STANDARDS FOR COMPARISON requires the integration or interfacing of the functions of estimating, scheduling and control. From an information processing viewpoint the optimal way of relating these functions is by using identical work breakdowns in each and a detailed activity and cost coding system. Difficulties are encountered with such an interfacing mechanism, however, because the thought process used to estimate and prepare a budget for a project differs from that used to plan and control the activities required to build it. This issue, because of its central importance to the development of useful PMIS requires more work. To date, many general contractors have not resolved it in a satisfactory way.

The variable INFORMATION PROCESSING points to the need to identify at the outset whether a PMIS will be manual or computer based. This decision reflects considerably on the request for number and frequency of reports that can be generated, and on the sophistication of data processing and analysis algorithms. It thus interacts with the key variables EVIDENCE and MODE OF PRESENTATION (section 2.5). Use of the computer requires that decision making processes be made explicit if they are to be delegated to the machine and that careful assessment of the value of various information inputs and outputs be made. The availability of a computer should not be used as the basis for justifying the collection and output of excessively detailed data and information.

2.2.3.3 Control System Variables - Control Variables and Management Action

MANAGEMENT ACTION consists of manipulating a set of CONTROL VARIABLES in order to ensure execution of a project within its time cost and content objectives. These variables include plan, schedule, budget, labour, equipment, construction methods and supervision. Depending on the role played by the contractor, he may not possess direct control over one or more of these variables. For example, if a general contractor subcontracts a large proportion of the work, he relinquishes direct control over labour, equipment and construction methods. He can only control them indirectly through the others. Thus the MANAGEMENT ACTIONS that can be taken are a function of the role of the contractor as well as the variables PROJECT and ENVIRONMENT.

2.2.4 Summary

The selection of the most effective course of action to pursue for a given planning and control problem in construction is usually treated as a semi-unstructured or unstructured decision-making problem. The criteria for selecting one action as opposed to another and the model(s) used to compute values for these criteria are poorly understood at present. Additional work is required to identify the types of control problems encountered, the data required to describe them properly, the relationship of available control variables to these problems, and models which can be used to simulate the impact of manipulations in these variables in order to solve the problem at hand. The undertaking of the work is a prerequisite to the design of effective PMIS.

2.3 ORGANIZATIONAL CONTEXT

The variable organizational context relates to the way in which the firm organizes itself and assigns duties and responsibilities to its members. Mason and Mitroff cite two ways in which the relationship of this variable and the design of an MIS may be explored. The first way deals with the kinds of problems the organization must solve and the resultant managerial activities. The second way deals with the "information pathologies" that arise as a function of organization structure.

2.3.1 Kinds of Problems

The authors referenced the work of Anthony (3) which categorized the problem types faced by an organization into three groups as follows:

(1) Strategic Planning is the process of deciding on objectives of the organization, on changes in these objectives, on the resources used to attain these objectives, and on the policies used to attain these objectives and on the policies that are to govern the acquisition, use and disposition of these resources.

(2) Management Control is the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organization's objectives.

(3) Operational Control is the process of assuring that specific tasks are carried out efficiently and effectively.

This clarification of problem types is a useful one and has been widely adopted in the literature. Key issues to be addressed include:

(a) the types and nature of problems encountered within each category

(b) the type and nature of information needed for their solution

(c) what assistance can an MIS provide for problem solving in each category.

By way of illustration of the problem types in each category, Anthony (3) gave several examples which are presented in Table 2.2. Gorry and Scott Morton (14) analyzed the nature of the information required for the solution of these problem types as shown in Table 2.3. The authors noted that the information requirements of these types of management activities are significantly different and that this difference goes beyond simply aggregating the data from one activity for use in another. A major implication of this observation is that the concept of a total integrated information system may not be a workable one as no clearly definable information interface exists between the three types of managerial activity.

The authors go on to point out that a useful second dimension to add to Anthony's framework is the notion of degree of problem structure. As indicated previously in Section 2.2.3.1, they define the notion of structured, semi-structured and unstructured problems and suggest that to date, most MIS work has focused on structured operational control management decision problems. They propose that what is needed is not more work in this area but in the tackling of MIS design for unstructured problems in the areas of managerial control and strategic planning because the successful solution of decision problems in these areas is of great significance to the long term well-being of the firm.

While contractors do not think directly in terms of operational control, managerial control and strategic planning (at least those interviewed for this thesis did not use such terms), project staff tends to be organized and assigned responsibilities compatible with such a division of activities.

The project related decision making of senior management spans all three activity types, but concentrates mostly on management control and strategic planning. Decision problems in these categories include determination of project duration and markup, assignment of project management and supervisory personnel, review of progress reports and initiation of management action as required, monitoring of operations to ensure that procedures are being followed, etc.

The project manager's function is largely one of management control and involves the development of a plan and schedule for the work, selection of construction methods, site layout, measurement of progress, etc. The focus of the superintendent and foremen is operational control and deals with the day-to-day allocation of resources, pushing of work, coordination, record keeping, ensuring that execution of activities is done according to schedule, etc. A comprehensive list of duties of project personnel may be found in

Appendix V and is based on a review of the literature (7), (11), (13), (22), (25). Many of the decriptions of roles of personnel in the literature tend to be normative as opposed to decriptive - i.e. what functions various levels of management should perform as opposed to which ones they in fact perform. In many building construction firms, personnel in positions of project management and senior mangement have come up through the ranks. Thus there can be and is a tendency to concentrate on management activities that they feel most comfortable with, which in most cases means that they may focus a large share of their attention on matters of operational control of projects. Further, they are often reluctant to depend on data generated by others and therefore seek to collect the detailed information necessary for decision-making themselves. These practices have important implications both for the design of MIS as well as for the education of senior management personnel.

2.3.2 Information Pathologies

With respect to information pathologies, which are organizational structure and people dependent, Mason and Mitroff cite the work of Wilensky (26) in which he demonstrated that hierarchy, specialization and centralization tend to create "information pathologies" (e.g. secrecy, blockage, withholding information, leaks, distortion, etc.) in organizations. To determine if such pathologies exist within an organization, one must possess knowledge of the interdependencies of the firm's information system, organizational structure and people. To date, little research on this aspect pertaining to construction has been performed. One piece of work that demonstrates how this problem could effectively be tackled is that of Kaiser and Woodhead (15) in which they examine construction company management functions and develop decision networks for the decision problems embodied in these funtions. The intent of the decision network is to show the information inputs required for each problem, the information processing to be done and the information and action outputs initiation required.

Identification of such networks for a firm should show how information actually flows (which may bear no relationship to the formal organization chart) and where bottlenecks may occur. Few contractors think in terms of information flow and even fewer document in written form how information on the firm's projects is collected, processed and distributed.

Ein-Dor and Segev (12) conducted an exhaustive literature search to determine the relevant variables which may be used to describe the impact of organizational context on MIS design, and in particular on the success of MIS within the firm. They associate success of a MIS with the extent of its use by management. The authors identify organizational context variables and classify them as uncontrollable, partially controllable and controllable with respect to the organization's ability to manipulate them. These variables are shown in Table 2.4. The authors postulate twenty-two propositions regarding these variables and the potential for MIS success in the firm. Of interest here are the following propositions.

Proposition 1. MIS projects are less likely to succeed in small organizations than in larger ones.

The basis for this proposition lies in the differences which exist between small firms in the areas of resource availability and degree of formalization of organizational systems. The fact that most construction firms are small (less than $50 million a year as opposed to say large manufacturing firms $500 million and up) coupled with the cutthroat nature of the construction business means that they have extremely limited resources to commit to the development of MIS. As well, their procedures tend to be premdominantly informal ones. Thus the time and resources required for PMIS must be found from outside the firm.

Proposition 3. The shorter the organizational time frame, the greater the likelihood of MIS failure.

The technical characteristics of an industry and the nature of competition in it can have a considerable influence on a company's time frame. Highly competitive environments dictate a need for fast decisions. In such environments, smaller companies are more likely to be pressed into short decision cycles than are larger ones. This environment is descriptive of the one in which most contractors find themselves. Consequently they do not have the time required to develop an extensive MIS system themselves but require some external agency to do the work.

Proposition 10. The more mature the organization, the greater likelihood of successfully implementing MIS.

The following paragraphs extracted from reference (12) are highly descriptive of the situation faced by many contractors. Note the relationship to several issues raised in section 2.2 and section 2.4

"We define mature organizations as those in which systems are formalized, quantified and produce data appropriate to their decision and control processes. Given this definition, old established organizations which are run informally and intuitively may be very immature, whereas a new, rationally structured and well planned organization may be very mature in spite of its youth".

"In order to construct a formal description of an organization it must be sufficiently well understood so that the relevant variables can be identified. If an analytic model is under consideration, understanding must be deepened to the point where relationships between the variables can be clearly stated".

"The construction of formal information systems requires not only that processes be well understood, but that they also be presented in a form suitable for processing and analysis. This usually implies quantitative rather than qualitative description. Systems can be quantified only if data are both available and accessible. First, some of the data required for decision analysis may not have been collected in the past, or may be available only in a form unsuitable for use without considerable massaging.

Second, the desired data may exist somewhere in the organization, but are of little use because of the difficulty entailed in actually putting them together".

As demonstrated by Revay (19), substantially increased efforts are required by contractors to collect the basic data necessary for time, cost and content control of projects. As seen in the case studies in the following chapters, most firms are relatively immature in terms of the foregoing proposition. Thus changes in their mode of operation are required if PMIS are to succeed and benefit the firm.

Proposition 12. MIS success and organizational maturity are normally dependent.

Proposition 15. The generation of position attitutes increases the likelihood of MIS success.

At present, many senior management personnel are skeptical of the ability of project personnel to provide accurate quantitative information on project progress. Thus they are not usually supportive of the implementation of formalized reporting procedures. They tend to focus on the failures that other firms have experienced when computerized PMIS have been adopted and they downplay the successes. A major problem they encounter at present is that there is no documented body of knowledge which is directed at showing how such systems may be designed and tailored to meet their needs and how they can educate personnel to respond positively to the use of such systems.

2.3.3 Summary

This section has explored a framework for examining project planning and control decisions. It involves identifying the type of managerial activity involved (strategic planning, management control, operational control) and the degree of problem structure. By examining problems in this manner, improved understanding of the roles of personnel can be developed, the value of information can be assessed and explicit models of decision processes developed. It would appear that the involvement and cooperation of senior personnel of construction firms is essential to this task if the potential benefits of formalized PMIS are to be realized. An important decision to be made by PMIS designers is the degree of integration such systems should have to meet the needs of the three types of managerial activity. This decision should await the development of an improved understanding of the firm and the planning and control process.

2.4 PERSON AND PSYCHOLOGICAL TYPE

2.4.1 Psychological Type

To date the importance of psychological factors concerning the user have not been treated in the literature dealing with MIS for construction. The implicit assumption that owners conform to a uniform mode of perceiving and evaluating problems seems to have been made. In actual fact, however, various psychological factors affect the decisions made by individuals. One individual may need to examine a large number of facts before arriving at a decision, while another individual may arrive at the same decision using few facts and extrapolating intuitively beyond them. The intent of this section is to create an awareness of different methods of decision-making to be considered as part of a framework for research for MIS for the building contractor.

Mason and Mitroff (17) describe a person as being characterized by four dominant psychological functions or modes. Two functions are related to the "Perception" of an individual, and the other two are related to "Evaluation" of the objects that an individual perceives. The alternate modes of perception are identified as "Sensation" and "Intuition"; the alternate modes of evaluation are identified as "Thinking" and "Feeling". These modes are described by Mason and Mitroff as follows:

Modes of Perception

Sensation type:

- relies primarily on data received from his senses in order to perceive the objects of the world
- is objective, looks at hard facts and pays attention to detail
- perceives objects as they are, in isolation and in detail
- guided by facts, careful not to extrapolate them
- may be data bound; takes too long to make a decision, afraid to risk

- his forte is day-to-day operations management
- speaks of raw data, numbers; information is empirical - no theory

Intuitive type:

- perceives objects as possibilities, as they might be and in totality
- sees through the facts and extrapolates beyond them
- may be too data free, may make hypothetical conclusions fast which may not be based on facts
- his forte is strategy making
- information will be in the form of imaginative stories and sketches of future possibilities

Modes of Evaluation

Thinking type:

- relies primarily on cognitive processes
- evaluates along the lines of true/false judgements, which are based on formal systems of reasoning
- systematizes
- formulates models; may be model bound
- makes formal rules
- often becomes a slave of his own system
- information is symbolic

Feeling type:

- relies on affective processes

- evaluates along personalistic lines of good/bad, pleasant/ unpleasant and like/dislike
- takes moral stands
- information takes the form of art, poetry, human drama, and especially stories that have strong moral components

Thus individuals may be categorized as follows:

a) Thinking-Sensation

b) Thinking-Intuition

c) Feeling-Sensation

d) Feeling-Intuition

Mason and Mitroff state that by no means the above is the only personality typology that can be used, however, they consider it to be the most suggestive for reseach hypothesis. Although four possible combinations are presented, some may be more likely to be representative of people than others since individuals generally tend to be consistent in the manner they perceive and evaluate problems. Individuals who belong to each of these types have their own concept of information and how it should be processed; what may be seen as very informative to one may have little importance to another. Based on these concepts it would appear that, ideally, a management team should be composed of a proper blend of each of these psychological types.

The job of the designer of an MIS is not to force all types to conform to one, but rather to give each psychological type information in a form that he is psychologically attuned to and will use most effectively. According to Mason and Mitroff the literature on the sociology and psychology of science indicates that science (including management science) has tended to project the "thinking-sensation" type onto that of their clients, consequently neglecting almost totally an MIS designed for Feeling and Intuition types.

This phenomenon also applies to construction, and the development of MIS has tended to be model-bound and data-based. This requires personnel who are the psychological types attuned to this format of information handling. The only firms that have this personnel are those which are very large in size, get involved in very large heavy construction projects, and carry a large project management staff. The building contractor is unlikely to have such a mix of skills.

Building contractors do not analyze management personnel in terms of psychological types explicitly. However, the roles people within the firm assume and their preference in mode of gathering, processing and transferring information, locating problems, and initiating action reveal their predominant mode of evaluation and perception of problems. The evaluation mode includes the procedures of gathering and processing information, and the perception mode includes the procedures of locating and defining problems and taking the necessary action. With respect to project control, the different psychological types perceive and evaluate problems in different ways. Some of the differences may be demonstrated by comparing individuals of each "evaluation-perception" category in relation with the parameter project progress.

The "thinking-sensation" type operates mostly in a formal mode. He relies heavily on information from reports to arrive at decisions. He would require extensive reporting with regards to the measurement of labour time and cost, material and equipment usage and subcontractor performance. He would formally process the information and generate labour cost reports, bar charts materials and equipment cost reports etc. Based on this information he would locate problems. He would take action by making the required changes such as resource leveling, processing the information again, re-examining the results and, if satisfactory, implementing them in the field. The "thinking-sensation" type is most suited for implementing an MIS which uses complex techniques and large amounts of input data.

The "thinking-intuition" type operates in a formal mode for evaluating progress, however, he would rely on past experience to perceive problems. He most likely, would generate similar reports (although not the same in number) from the site and process them as the "thinking" type would. He would rely on intuitive processes based on past experience to perceive problems and take action. In other words he has done all the processing of information so that he can make decisions and to that he adds his previous experience and determines the necessary action. An MIS for the "thinking-intuition" kind need not be as sophisticated as that for the "thinking-sensation".

The "feeling-sensation" type would gather data on project progress through informal modes such as visual inspections of amount of work done and conversations with job superintendents. The information would not be recorded nor formally processed to generate reports. Based on this information, problem areas are identified and formal action is taken. An MIS for the "feeling-sensation type is based at best on approximate information and accordingly could generate inaccurate results.

The "feeling-intuition" type operates totally informally. He measures progress at the site through visual inspection. He relies on previous experience to evaluate the situation, intuitively he locates the problem area and may quickly suggest what action to take. For example he visits the site, sees actual progress, relies on previous experience and feels that the project is behind schedule, acccordingly he may suggest on the spot to the subs to work overtime. A formal MIS would serve very little purpose for the "feeling-intuition" type.

Interviews conducted with personnel in the three case studies of this thesis did not have as a direct intention to fit individuals into one of the four "perception-evaluation" categories. Nevertheless it was observed that the tendency for decision-making of the individuals in the firms was towards intuitive processes based on past experiences. One of the reasons for this is that contractors are required to make decisions very quickly and therefore have little time for reflection and formal processes for examining all the available facts. Although a more in-depth analysis of the modes of evaluating and perceiving is required, present indications are that if designers of MIS devise sophisticated techniques which are very formal and rigid, the building contractors will continue to alienate themselves from such systems as they have until today.

A characteristic of the building contractor is that, by and large, its project management personnel have reached their present positions by moving up through the ranks of the firm. It is apparent that the firms tend to stay away from hiring outside expertise. When need for help arises individuals within the firm are promoted. However, the skills which senior management seeks in these individuals are usually similar to their own, thus creating the same psychological type throughout the firm.

2.4.2 Person

Mason and Mitroff do not define the term PERSON. The person in this thesis refers to the decision-maker and the user of the MIS. For the construction firm for purposes of project management the persons involved are: senior management, project managers, estimators, project engineers, job superintendent, and foremen. Some of these are direct users, and some indirect users. Each of these individuals plays a different role in the MIS as was previously described under organizational context. An example of work related to the variable PERSON is that of Borcherding (6). He focused his attention on the role of the foreman and collected information by making use of questionnaires and interviews. He documented the results with respect to the motivation, and the procedures in selection, evaluation, recognition and compensation of a foreman. He points out that significant differences exist between the functions of a construction foreman and an industrial first-line supervisor. His work is of interest since he deals with behavioral aspects of one individual with respect to his managerial functions. He has not, however, investigated other individuals, nor has he applied his findings to the problem of MIS.

Based on findings from the present case studies, there are significant differences between the author's concept of the foreman's managerial functions and those described by Borcherding. This is largely due to the differences in the character of the firms surveyed and the volume of work.

Possible variables which can be attributed to the persons involved in MIS are: Age, Education, Experience, Technical Skills, Communication Skills, Management Skills, Ambition, Responsibility, Motivation, and Openness to New Ideas. These variables must be considered by designers of MIS since they describe the personal characteristics of the users. Table 2.5 shows these variables as well as some possible implications for an MIS.

2.5 EVIDENCE AND MODE OF PRESENTATION

Information is the evidence upon which the manager's decisions will be based; this evidence is conveyed via some mode of presentation. Mason and Mitroff (17) state that a manager will tend to rely on some methods of generating evidence and exclude others because he places more confidence in the truthfulness of the evidence generated by the former methods. Based on a philosophical approach they put forth five methods of generating evidence. These are:

a) Data based methods - Starting from a set of elementary empirical judgements (raw data from observations or sensations), one builds an empirical inductive representation. Examples are data banks, accounting and statisics.

(b) Model based methods - Starting from a set of elementary, primative formal truths, one builds a formal, mathematical or symbolic representation. Information is derived from models or proved from axioms and conveyed symbolically. Examples are bar chart and CPM.

(c) Multiple Models - They give two or more explicit views as one builds at least two alternative models for every problem. These are best suited for handling problems of "moderate" ill-structure.

(d) Conflicting models - One builds at least two completely different representations of a problem. These are best suited for "wickedly" ill-structured problems.

(e) Learning systems - They involve learning through feedback.

Mason and Mitroff (17) give more in-depth descriptions of each of these methods. They also mention that to date, designers of MIS have almost exclusively relied on the data based and model based methods of generating evidence, ignoring the other three.

Dickson et al (10) state that historically designers of MIS have paid little attention to the ways people use information and sometimes have tended to produce "data for the sake of data". Parts of the results from their research which they propose should be considered by designers and researchers in information systems are outlined below:

1. Complex models and/or "hard to use" systems may have little impact on user decision-making
2. Systems with complex or unfamiliar attributes may produce low user confidence and satisfaction with the systems even if operating results are better. These attributes represent a potential barrier to successful implication that training may not be able to overcome.
3. Managers like to use interactive systems and their use enhances acceptance of information systems generally.
4. Information systems designers should be sensitive to individual differences in users. Unfortunately the relevant attributes vary by type of decision problem and information system.

5. The existing research has clearly demonstrated that there is an important system/user/decision interaction operating which affects the performance results and user evaluation of an information system.

Chervany (8) states that the understanding of the user/problem/MIS interface is essentially non-existent. He poses the following questions:

1. What level of summarization of data produces the best (and lowest cost) decision in a production decision environment?
2. How do the training experiences and/or risk taking characteristics of a decision-maker influence the form in which information concerning environmental uncertainties should be presented?

According to Mason and Mitroff (17) most MIS designs assume without question that the computer is the heart of a system. They believe, however, that the method of evidence and mode of presentation are linked to the psychological type, and even though the computer provides correct and complete reports, it is impersonal and may not appeal to Feeling and Intuition types, these may prefer verbal modes such as group discussion.

The intention in citing the above literature is partly to create awareness of the methods of generating evidence and modes of presentation and some implications. According to the literature, information is evidence which must be generated and presented in a manner best suited for the user. The manner in which the variables EVIDENCE and MODE OF PRESENTATION are handled by contractors is demonstrated in the case studies presented in the following chapters.

Revay (20) has also investigated the area of project control for the building contractor which deals with site reporting. He put forth a work instruction plan which incorporates a monthly bar chart with the instructions needed by site personnel. This is issued to the foreman, weekly. It is intended to allow field supervisors to concentrate on increasing productive working time. However his format contains exhaustive technical information which may be too demanding on the foreman especially if the latter does not excel in formal communication skills.

Barrie and Paulson (5) point out the various reports which can be generated for control after the information from the field is processed. They suggest that this reporting must provide a straight forward statement of the work accomplished, predict future accomplishments in terms of project cost and schedule, and measure actual accomplishments against goals set forth in the plan; in addition, current and potential problems should be reviewed and management action underway to overcome the effects of the problems indicated. What is left to determine is the amount of evidence and the mode of presentation ideal for project control for the building contractor.

The designer of an MIS for the building contractor should direct his attention at determining the evidence and mode of presentation which is relevant to project control as well as Person and Psychological type. More specifically the questions which must be answered and which are reflected in the questionnaires in Appendix I, are:

1. What information must be gathered from a project and how often?
2. What is the format for gathering information which is suitable for proper control and at the same time can be clearly understood by those collecting and analyzing the information?
3. What is the most appropriate method for processing information from the points of view of acceptability and compatibility with the personnel and effectiveness in generating the information required for control?
4. What is the minimum information required for effective control?
5. What feedback can be obtained by the decision-maker (usually the project manager) from the information so that he can take effective action?

These questions can not be answered simply by supplying the building contractor a series of forms serving various purposes, to be completed by his management staff, because these are already available and are not implemented. A concerted effort is required to develop workable reporting and information systems for the building contractor and to educate all levels of management personnel as to the benefits to be achieved through their use.

PARAMETER	ATTRIBUTE	ATTRIBUTE VALUE	IMPLICATION FOR CONTROL & PMIS DESIGN
PROJECT	SIZE	Small	Project will not permit sufficient overhead to have extensive site staff to maintain detailed records. PMIS data requirements must not exceed capability of site staff to gather data.
	FORM		
	TECHNICAL COMPLEXITY		
	DEGREES OF DEFINITION		
	DURATION		
	FAMILIARITY	Very Familiar	Previous experience with projects of similar type may lead to belief that high level of formal reporting not required. PMIS designed to provide feedback on finished job of significant use for further projects of similar type.
	CONTRACTUAL ARRANGEMENT	Cost Plus	Must demonstrate to client that have effective control system for control of time, cost and content. PMIS must be designed to track time and cost variables.
	% SUB-CONTRACTED	High	General contractor has relinquished control over the variable construction operations. Can exert control indirectly through schedule and joint subcontractor reporting function. Level of detail in project breakdown, much less extensive. Less data to collect, process, present.
	GC WORK FORCE SIZE		
	USE		

TABLE 2.1 - PROJECT ATTRIBUTES

Strategic Planning	Management Control	Operation Control
Choosing company objectives	Formulating budgets	
Planning the organization	Planning staff levels	Controlling hiring
Setting personnel policies	Formulating personnel practices	Implementing policies
Setting financial policies	Working capital planning	Controlling credit extensions
Setting marketing policies	Formulating advertising programs	Controlling placement of advertisements
Setting research policies	Deciding on research projects	
Choosing new product lines	Choosing product improvements	
Acquiring a new division	Deciding on plant rearrangement	Scheduling production
Deciding on non-routine capital expenditures	Deciding on routine capital expenditures	
	Formulating decision rules for operational control	Controlling inventory
	Measuring, appraising, and improving management performance	Measuring, appraising, and improving workers' efficiency

TABLE 2.2

EXAMPLES OF ACTIVITIES IN A BUSINESS ORGANIZATION INCLUDED IN MAJOR FRAMEWORK HEADINGS (3)

CHARACTERISTICS OF INFORMATION	OPERATIONAL CONTROL	MANAGEMENT CONTROL	STRATEGIC PLANNING
Source	Largely internal →		External
Scope	Well defined, narrow →		Very wide
Level of Aggregation	Detailed →		Aggregate
Time Horizon	Historical →		Future
Currency	Highly current →		Quite old
Required Accuracy	High →		Low
Frequency of Use	Very frequent →		Infrequent

TABLE 2.3

INFORMATION REQUIREMENTS BY DECISION CATEGORY (14)

	VARIABLE	OPERATIONAL MEASURES
UNCONTROLLABLE VARIABLES	Size of the organization	annual sales; work force; assets; market share.
	Organizational structure	number of product-market units; number of profit centres; number of divisions; number of groups.
	Organizational time frame	planning horizon; average length of strategic decision process; rate of technical change in industry.
	Extra-organizational situation	availability of trained manpower; availability of hardware; availability of software; availability of decision techniques.
PARTIALLY CONTROLLABLE	Organizational resources	size of budget; liquidity.
	Organizational maturity	degree of system formalization; level of qualification; availability of decision-relevant data.
	The psychological climate	attitudes to information systems; perceptions of information systems; expectations from information systems.
FULLY CONTROLLABLE	Rank of the responsible executive	number of levels below chief officer.
	Location of the responsible executive	identification with specific functional area.
	The steering committee	existence; organizationl level.

TABLE 2.4

SUGGESTED ORGANIZATIONAL MEASURES FOR
ORGANIZATIONAL CONTEXT VARIABLES (12)

PEOPLE VARIABLES	POSSIBLE IMPLICATIONS
AGE	- a person over 45 is usually set in his ideas; it is more difficult for him to adopt new ideas
EDUCATION	- higher technical education implies more inclination to model based methods and more quantitative information; easier to convince on need for formal reporting - higher education implies greater acceptability of new ideas
EXPERIENCE	- success in past endeavours and resulting know how may prove barrier to change - experience indicates the level of confidence in a method of operating and on project planning and control
TECHNICAL SKILLS	- higher technical education better understanding of technical aspects - possess the ability to understand CPM - perceive usefulness of computer and know computer programming - adopt a formal project control system - better grasp of more sophisticate techniques and available technology
COMMUNICATION SKILLS	- ability to give written reports; memos - low formal skills imply must rely on informal methods such as conversation
MANAGEMENT SKILLS	
AMBITION	
RESPONSIBILITY	
MOTIVATION	
OPENNESS TO NEW IDEAS	- open to new ideas implies willing to make changes, innovative

TABLE 2.5 - PEOPLE VARIABLES

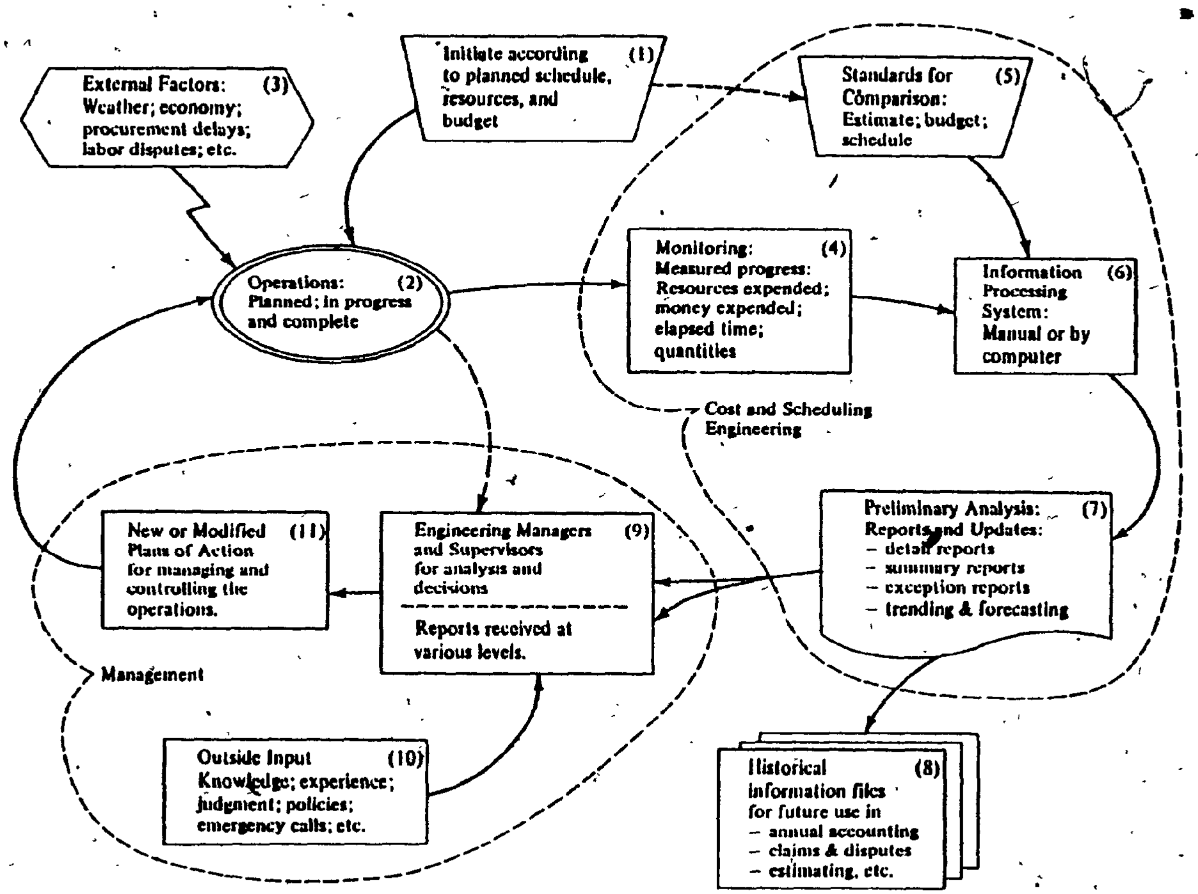


FIGURE 2.1 - FLOW CHART OF PROJECT CONTROL SYSTEM (5)

CHAPTER 3

CASE STUDY I

3.1 INTRODUCTION

The firm investigated is a successful non-residential building contractor based in Montreal. Interviews were conducted with four individuals, the vice president, one project manager, one estimator and one job superintendent. A second project manager completed questionnaires for the project manager, superintendent and foreman. All interviews were arranged through the vice president and they were conducted in private; each individual was not aware of the others' replies and senior management did not participate in any of the other interviews except that one specifically pertaining to it. The author and his supervisor from the Centre for Building Studies conducted all interviews except for the one with the superintendent, which was conducted by the author alone. Interviews took place on the firm's premises, construction site and at one individual's private home. They spanned a period of 5 months. The firm granted permission to record all interviews and offered complete cooperation throughout this process.

Questions were directed at the identification of roles of personnel at various levels and their attitudes with respect to project management. Emphasis was placed on the collection, processing, retrieval and use of information. Because the interview process is very time consuming for the firm, there were restrictions on the amount of information which could be obtained. It was found that detailed interviews such as those conducted were much more revealing than the use of questionnaires alone. It became clear that since individuals are given substantial leeway in the way they operate, more people would have to be interviewed to obtain a more complete picture of the firm.

The reader must constantly keep in mind that the interpretations of the comments are those of the author and his supervisor alone. It is also important to note that a slowdown is presently existing in the construction industry in Canada; this is more acute in the province of Quebec (Refer to Chapter 1). Therefore the present situation is not considered "normal" and this firm, as many others, is working at a slower pace than it used to. The consequences are that it is faced with possibilities of reductions in staff or even closing its doors on a temporary basis.

3.2 CHARACTER OF THE COMPANY

3.2.1 Market

The company is a general contracting firm based in Montreal. It is owned and managed by 3 individuals, 2 of whom are related. Its origins date back to 1947 when it operated as a residential contractor. With time the firm became involved in the construction of high rise apartments and office buildings. About 10 years ago it evolved to building commercial developments. This evolution was not based on strategic planning but seemingly came about due to circumstances in the Montreal construction market. Over the last 10 years it has built over 50 shopping centres, some of which it owns. The firm is also involved in property management and development, however this aspect of the firm was not investigated.

Presently the firm operates in the province of Quebec, with 80 percent of the work concentrated in the Montreal area. In the past it has done limited work outside the province which was concentrated in Ottawa and Cornwall. There is no desire to explore other markets. In the words of the vice president: "I would rather put the key in the door than break our neck with a market we don't even know". Eighty percent of the firm's projects are in commercial construction and the remaining 20 percent are in light industrial construction. The yearly volume of work is between $10 million and $20 million. In 1976 the yearly volume of work was up to $30 million. The decline is principally due to the poor economic situation of the province and is common throughout the industry. Prior to the decline, the firm's estimated average annual rate of growth was 10 percent. If one considers the effect of inflation, the firm has achieved little if no growth at all. At any one time the firm may be involved in 6 to 10 projects which may range in value from $500,000 to $12 million and may have a duration of 4 to 18 months. The breakdown of the contractual arrangements for these projects is approximately as follows; 40 percent on a fixed price basis, 40 percent negotiated contracts and 20 percent on a management basis. When the firm enters into competitive tendering, the rate of success is one job for every 16 bids which is in line with the industry average.

3.2.2 Firm Objectives

The main objective of the firm is to develop a reputation for timely completion of projects within budget. This is the focal point of their advertising. Monetary returns, although a priority, are viewed as being directly related to the timely completion of projects within budget, since the latter creates a repeat of business. In fact, the bulk of the work is from the repeat of business. Growth is not considered an objective nor a priority. Since much of its work is negotiated, the firm is given a free hand in suggesting savings to the owner, and the firm's managers work as a team with the owner and the architect. Gross profit on work ranges from 3 percent to 5 percent which is considerably higher than industry average. This stems from the high quantity of negotiated work.

3.2.3 Organizational Structure

Head office staff consists of 20 people and it includes 3 senior executives, 5 project managers, 3 estimators, 3 accountants, 3 office administrators, 1 contracts manager, 1 payroll master and 1 controller. Site personnel maintained full time includes 7 superintendents and 7 foremen. This has tended to remain stable over the past 10 years although some shrinkage of project staff has occurred due to the slowdown in construction in the Quebec market.

Figure 3.1 illustrates the organizational hierarchy of the firm's head office management personnel. Figure 3.2 through 3.5 illustrate the organizational hierarchy of the project management personnel. These were sketched by three different individuals within the firm. The fact that there are major differences among the organizational hierarchies sketched by different individuals indicates that the personnel in the firm do not think in terms of organizational structure. The vice president says: "Sometimes I think we are overstaffed . . . Other contractors do not work like we do, with a superintendent, a foreman and a project manager; they might have just a carpenter foreman on the job and he'll bang in the odd nail".

3.2.4 Project Characteristics

There is no set monetary figure that separates projects into distinct categories such as small, medium and large. Nevertheless a project worth over $2 million is generally considered by the company as a large project. Seventy percent of the firm's projects are of large size; and consist of commercial buildings whose average value is $10 million and average duration is 12 months. The average work force for these projects consists of 150 people at peak time of which 50 are workers directly on the payroll of the firm. Typically 70 percent of the work is subcontracted.

The nature of the work done by the company's own forces consists of masonry, general carpentry and general labour. In the past when masonry was subcontracted it was often a source of problems. Consequently, the firm employed a former subcontractor to work as its masonry superintendent. The firm has been doing its own masonry work for 17 years.

The company owns only equipment which is needed continuously for the work done by its own forces. Other equipment and heavy machinery such as cranes or shovels are rented for the period of time that they are needed.

3.2.5 Project Records

Project reporting is mostly done verbally; thus, very few formal records are kept. Job records which are kept at the site include a weekly progress report, minutes of progress meetings, weekly time sheets, material delivery report and equipment rental report. Records kept in the office include project estimate, change order quotes, budgets, when calculated, progress claim reports, weekly progress reports, minutes of progress meetings, weekly time sheets, labour cost reports, material delivery reports and equipment rental reports. Other records may be kept by the project manager at his own discretion, however, they are not required by the firm. All job costs are kept in the office; no records of costs are kept at the site.

3.3 GENERAL MANAGEMENT POLICY AND PRACTICES

3.3.1 Procedures of the Firm

The company has no policy handbook which spells out the roles and responsibilities of personnel and company procedures to be followed at all times, nor any formal training and upgrading program for its personnel. This has not been found necessary since the number of management employees is rather small and the turnover of personnel has been low. Present management personnel have been with the firm for a long period of time; consequently they have adjusted to one another as well as to their roles and the responsibility and authority delegated to them. The informality and vague definition of roles leads to flexibility of the firm's personnel. Two people with identical title can in effect have different duties. This is viewed by senior management as contributing to the success of the company. This flexibility also assists senior management in keeping on top of the projects. The vice president says: "We let the project managers think they are running the job, but in fact we know what is going on and if we hear or see something that is not going quite right, diplomatically we suggest to them that there is a better way to do it".

3.3.2 Employee Training

In the hiring of personnel, emphasis is not placed on educational background, but rather on work experience. The company does not have any engineers amongst its employees. When looking for an estimator the advertisement in a local newspaper partially read: "Please reply in writing only stating previous experience and particulars". When a new employee is hired, the only training he receives is on-the-job training. Superintendents are former tradesmen who have come up through the ranks.* They started off as assistant carpenters, became carpenters, then foremen, and finally superintendents by waiting until the right job came along for them to handle. Two superintendents have gone on to become project managers. One other project manager used to be in business for himself, so he came to the company already experienced. Estimators as well have obtained most of their training on the job. One estimator has some technical training in that he was enrolled in an engineering program at university in which he completed three of fours years. One other estimator, the son of the vice president possesses a general arts degree. Some employees through their own initiatives have enrolled in evening courses in order to expand their knowledge and speed up the process of advancement to fulfill their ambition. Typical of the courses attended were blueprint reading and estimating.

3.3.3 Motivation

Being a family business, the senior management positions will always be held by family members which leaves little room for advancement for middle management personnel. At present the owners have several sons who are coming of age; to date only two sons seem to be getting involved in the affairs of the firm. Rewards to middle mangement and supervisory personnel are issued in the form of salary increases, bonuses, and fringe benefits.

3.3.4 Reporting Practices

Instructions to employees are given verbally because some individuals cannot work with written instructions. Employees are not asked to make written reports except in special cases for settlement of disputes. Project managers are left to operate freely in the execution of a project with very few guidelines. One project manager documented the various management functions and job descriptions; these he uses for personnel involved in the projects he manages; however they are not adhered to company wide.

3.3.5 Computer Usage

The company does not own a computer. Computing services are used only for payroll. Interest was expressed for computerizing accounts payable to use in comparing anticipated costs with actual costs for each item of work. This however was not followed up because being a general contractor, 70 percent of the work is the responsibility of the subcontractors and it was felt that insufficient use of the machine would be made, which would not justify an expense estimated at some $25,000 to $30,000. Senior management does not have the confidence in the accuracy of the information to be fed into the computer. Their views are expressed by the vice president as follows: "Even if I had that, (computer reports) unless I ran the job to see how the work is done and if I would be given intelligent information, I would not trust it".

3.4 PERSONNEL

In the interviews with the individuals previously described, emphasis was placed on their roles with respect to individual project planning and control and in particular on their collection, processing, retrieval and use of information. Due to the flexibility, and informality of the firm, some peculiarities of procedure arise which should be mentioned here. It is possible, for instance that two individuals holding the same title may not have the same authority or responsibilities. Each may proceed in a different manner to get the work done. It is also important to note that there is flexibility in the organizational hierarchy of the personnel: the superintendent, for example, may report on certain matters directly either to the vice president or secretary-treasurer or both. Some difficulties were encountered because of the informal nature of the information transfer within the firm. There is a lack of written information; the tendency is to transfer information verbally. This firm is like other firms investigated in that personnel are action oriented and thus have a negative attitude towards written documents.

3.4.1 Senior Management

Ownership and overall management of the firm are in the hands of the president, the vice president and the secretary-treasurer. Profit margins on work are determined by them, and actual profits are known only by them. The role of the president, an engineer, is to enhance the good will and reputation of the company. Accordingly he gets involved to some extent in marketing. He also devotes some time to property development and management. He is semi-retired and the remaining responsibilities are shared between the other two principals.

The roles of the vice president and the secretary-treasurer are not related to their titles; in fact their functions sometimes overlap and in the absence of one at meetings or discussions, the other can substitute. They are both aware of what each other is doing. Since the management structure of the firm is informal, the job functions are somewhat flexible and vary from project to project. A project manager may report to one on matters of cost and budget and to the other on matters on planning and scheduling. The vice president and the secretary-treasurer have both obtained their experience from on-the-job training and the education level of each does not go beyond high school. They control costs on the job by assigning themselves duties in project management which include overseeing of all project costs and spot checking of construction procedures.

Secretary-Treasurer

As it was not posssible to interview the secretary-treasurer, a detailed description of his duties could not be obtained. Instead, an overview of his functions was gathered from conversations with the other individuals in the firm. The basic duties of the secretary treasurer involve planning and scheduling and the operating of ongoing projects of the firm. They can be outlined as follows:

- definition of the work to be performed by the firm for each project
- policy decisions regarding the office and the yard
- control of all equipment
- coordination of meeting with project manager and superintendent prior to construction phase of a project to define potential problems.

Vice President

The vice president looks for possibilities of obtaining work, deals with clients and architects and oversees construction planning and control operations. The vice president is kept very busy with supervision of day to day operations. In addition, the firm has, in the past, tendered bids for up to 150 projects in a year, which leaves him with very little time for strategic planning. His duties are the following:

- supervision and expediting of accounts receivable and their coordination with accounts payable in order to maintain a positive cash flow
- participation in negotiating terms of negotiated contracts
- discussion with the client, his architect or engineer to ensure that the client's requirements are clearly

understood. This is a necessary procedure on negotiated contracts since there are no drawings and specifications at the outset

- preparation of a budget of estimated construction costs for the negotiated contracts
- supervision, control and approval of cost estimates prepared by the firm's estimators for submission on tendered bids. In effect the vice president acts as chief estimator
- assignment of project manager to a project prior to the start of construction, after consultation with secretary-treasurer
- supervision of project managers of projects under construction, and request of periodic oral reports on the progress of project with emphasis on possible dates of completion of portions of work, and on problems with subs or suppliers
- approval of all quotations for change orders and pushing architect for the issue of change orders for extra work already done
- resolve problems encountered with subcontractors' performance if these cannot be resolved at the project manager's level
- participation in day to day operations of the firm and in issuing work to personnel
- attend initial job meetings at the outset of construction to

aid project manager in acquiring familiarity with the job

- periodically estimate work done by subtrades so as to check the correctness of quantity of work done for the application for payment
- act as project manager if the latter becomes ill

Current Problems as Seen by Senior Managers

In the opinion of the vice president the biggest problem the company faces presently is that of a diminishing volume of work. To a large extent this is due to the slowdown in construction in the past few years especially in the province of Quebec which was seen in Chapter 1 of this thesis. This creates difficulties for the firm in obtaining new work and consequently in surviving. The company relies heavily on the private sector for building, and due to the political uncertainty existing in the province of Quebec, private speculators are afraid to invest. The market for light industrial construction has virtually collapsed since there are large quantities of unrented space available at relatively low prices. The market for shopping centres seems to be reaching its point of saturation also. In the words of the vice president: "There are too many apartment buildings, too much office space ... Every day we wonder where the next job is coming from, and there's none around to go after". The firm is having great difficulty in maintaining its present staff size and is faced with the prospect of having to lay off personnel.

The vice president expressed contentment with the firm's procedures for project planning and control. This is not regarded as a problem area for immediate attention. In his view the effectiveness of the firm's project control procedures depends on having good, conscientious, hardworking and experienced personnel. He has no confidence in formal reporting because information is sometimes manipulated and can be misleading. He is satisfied with the level of accuracy of the information he receives. He sees no need for a computer. He claims most of the difficulty in project control is encountered with subcontractors. This is partly due to the criteria for the selection of a subcontractor which stipulates that the sub with the lowest price be chosen.

3.4.2 Project Manager

The project manager is assigned to a project after the contract has been obtained by the firm, and is responsible for the management of the project. The project managers in this firm have many years of field experience although generally not a very high level of education; two among them have had education in a technical field; one of them is a quantity surveyor. The project managers have been exposed to all aspects of construction by making their way up through the ranks. In the words of the vice president: "Of the five project managers we have, they are all different. They come from different backgrounds. One senior manager has all kinds of records he keeps for himself and he records everything in writing. He is very efficient, however, I don't look at 90% of what he keeps records of. Another project manager doesn't write a thing down before the job gets done. He is not a tradesman, never was a tradesman. He's an organizer and the way he goes about it still works in the end. Another project manager was a tradesman, he knows sequences of work, knows what can be done and gets along well with everyone. The subs like him because he is fair. Half of them tend to be a little tough on subs and won't entertain extras. They are different individuals and I can't expect the one that works from his head to make me written reports, because he will give me junk".

The project manager interviewed is a senior in the company who has about 40 years of construction experience, the last 20 with the present firm in the capacity of project manager. His background includes attending a technical school, but no professional degree, and having been in business for himself. Therefore he came to the company already experienced. In his opinion: "I don't think there is such a thing as a project that we haven't done before, because every job consists of concrete, steel, earth moving etc. . . . If you're talking about a dam or you're talking about a one-storey building or a hundred-storey building, it's the same. It does not make any difference as far as I am concerned". He has, over the years, read a considerable number of books dealing with construction management and he tries to keep up to date with management techniques: he is the only one in the firm capable of scheduling using CPM. He believes in collecting formal information on the progress of his projects and keeps detailed files of job records. This is a sharp contrast with one other project manager who was portrayed as managing orally and keeping virtually no job records.

A normal day for the project manager consists of the mornings at the job site and the afternoons in the office. His main functions as described by himself are:

- act as liaison with architect and owner
- appoint superintendent and coordinate project start-up and project progress with him
- control the labour pool; keep manpower chart and discuss with superintendent manpower requirements and allocation
- schedule subcontractors and make them aware of their starting dates
- prepare project schedule
- act as chairman at weekly job meetings and record the minutes of the meeting
- initiate change orders for extras required by the owner or architect
- try to be alert on cost savings
- scrutinize the plans to simplify methods and procedures on the site and be consistent with good practice
- approve shop drawings
- report to vice president or secretary-treasurer weekly, verbally and informally on project progress
- expedite the required materials for the job

- assess physical progress by visual inspection.

In general, the money aspect of the project is handled by senior management, although some project managers know about some costs, and others do not. The basic responsibility of the project manager lies in the control of time and quality of the job. His main concern is to get the work done as quickly and as cheaply as possible. Assisting the project manager are the superintendent, the foremen and possibly a clerk. Their roles are described later in this chapter. The project manager interviewed observes site operations by frequent inspections during which he notes the progress and points out mistakes. He does not abide by rules of chains of command and he would not hesitate to address any man at the site to instruct him to do some work. He requests from the superintendent a weekly progress report (Figure 3.6) which he uses not to monitor progress, but rather to keep the superintendent on his toes. He believes superintendents have a tendency to protect their friends; therefore he controls the labour pool himself so as to always have the best men on the job.

After receiving the preliminary target dates for the project by senior management, the project manager formulates the final project schedules. Normally this is done in the form of a bar chart, although on occasion CPM is used for large size projects by this project manager. He is the only one in the company familiar with CPM and consequently the only one to implement it. He updates the schedule regularly for the initial part of the project; when the project is one third to one half complete, the schedule is abandoned and work proceeds simply through past experience. He says, "I hate to disillusion you, but so far as I'm concerned construction is still a business which you have to do by the seat of your pants".

In the opinion of the project manager most of the difficulty in project control is encountered with subcontractors. They have a tendency to take on too many jobs at once and consequently do not produce good, reliable work.

The project manager views the present strengths of the company as lying in the firm's own force. The workers are hard working men that have been with the firm a long time. However most of them are reaching retirement age and it is becoming increasingly difficult to get new people in construction who are ambitious and hard working. For this reason he believes that if the company intends to stay in business in the future they must start hiring engineers. He says ". . . . in our case we have stuck to practical men. Many companies hire engineers who become project managers. If we are going to stay in business, then the firm will have to start hiring engineers, because I can't see anybody coming out of the field and becoming project manager".

3.4.3 Chief Estimator

The estimating department consists of three estimators, though in the last 10 years there sometimes have been up to 5. They work individually rather than as a team. All estimators report directly to the vice president. Each estimator is assigned to a different project and his involvement begins at the time of the bid and lasts until the end of construction. Educational and experience backgrounds of estimating personnel vary considerably for each individual. One estimator started working at the age of 16 for a construction company as a general helper; he progressed with time to become an estimator and although now past his retirement age he is still working. One other estimator is the son of the vice president; a graduate from university in a non-technical field, he has worked as an estimator for 4 years during which time he has attended evening coures in blueprint reading and estimating. This resulted in an accelerated pace of development for him. The third estimator attended engineering school, but did not graduate; he has 15 years of experience of which the last 10 have been with the present firm. He is normally assigned the duties which carry more responsibility and the interview was conducted with him. The functions of the estimator were given as follows:

- carry out the quantity takeoff and pricing for the tender in the pre-bid phase of a project
- prepare along with the vice president the budget for management contracts and cash flow forecast for clients when the latter require it
- negotiate subcontracts under the supervision of project manager and vice president
- if firm is successful in obtaining a contract, inform the

project manager on details of the project to get pre-construction phase underway

- act as job captain during the construction phase

As job captain he is responsible for:

- preparation of project schedule for project manager (not for all project managers)
- estimation of monthly value of work done by subcontractors with assistance from the project manager and vice president
- evaluation of costs and delivery dates of materials and equipment for projects and selection of most feasible supplier
- preparation and submission of change order quotations
- preparation of subcontractor's change orders
- follow up on job meetings
- preparation of cost saving alternatives

Senior management does not require any formal progress reporting from the estimators; the only written requirements are the cost estimates themselves. In the case of negotiated contracts the estimators are required to calculate project costs from very preliminary drawings or simply sketches. The actual estimates are itemized according to the drawings and specifications of the architect. A list of items of work and relevant trades is drawn up; the final estimate is arrived at in accordance with this list. The work to be executed by subtrades is not always estimated; in such cases approximate costs per square foot are assumed. The estimator works closely with the project manager on the construction phase of a project. Sometimes he is required to do much of the paperwork for the project manager including the schedule which is usually in a bar chart form consisting of approximately 30 items, generally divided by trades.

Normally a good estimator does not encounter difficulties in making an accurate quantity take-off. Difficulties can be encountered in the costing of work. In fact the actual labour costs are often higher than the estimated ones. Despite this difficulty, no formal productivity records are kept, nor are records from previous jobs kept because it is believed that the productivity of men varies from project to project. The only standard breakdown used is for general conditions. There is no standard format used for the breakdowns of the work items.

3.4.4 The Job Superintendent

For every project there is a job superintendent who is responsible for the running of the job site. He is assigned to a project one week prior to the start of construction and together with the project manager studies the job to plan the way work will proceed. During construction he is stationed at the site; there he supervises the men, coordinates the trades, approves the quality of the work and handles day to day problems. The superintendent interviewed normally handles a $5 million to $10 million project with an average duration of 1 year. On such a job he would have 3 foremen and 20 to 25 labourers and carpenters. For the large projects, a clerk would also be employed to handle time sheets, receipts and phone calls for the superintendent.

The superintendent interviewed started to work in construction at the age of 16 as an apprentice carpenter. He has 25 years of working experience, all with the present firm. He is the youngest in the family of seven brothers who all work for the same firm. After 5 years of working as a carpenter he became foreman, and 2 years later, on his first job as superintendent, he was in charge of building a small warehouse. While working he enrolled in a school of arts and crafts for 2 years where he attended evening courses in carpentry and blueprint reading. He believes that the length of time it takes to become a superintendent depends on the individual's ability and ambitions; however he further believes that in his case the courses he attended speeded up the process. His main functions can be outlined as follows:

- participate in pre-construction meeting with secretary-treasurer to identify potential problem areas
- coordinate all subtrades on the schedule they are required to follow
- inspect subtrades daily to see if they report for work and record the number of men of each subtrade and the area they work in
- examine all the revisions on the plans as they arrive, and

distribute the revised plans to all subtrades at the site

- parcel out work ahead of time, and instruct the foreman on their portion of the work
- order material for the general contractor's portion of the work as is needed
- attend weekly job meetings to discuss and coordinate work
- discuss problems with project manager when the latter comes to the site
- control labour pool (when this is not done by project manager)
- keep material and equipment record if there is no clerk on the project

On the site the superintendent is guided by the schedule formulated by the project manager which is in the form of a simple bar chart, and by the project manager by way of his site visits. (The superintendent interviewed was not familiar with CPM). Periodically he fills in progress on the bar chart. For larger projects, a clerk is assigned to the site to look after the written reports. In his absence the reporting is done by the superintendent. His presence allows the superintendent to devote more time on actual visual supervision at the site. The clerk would take care of most of the paperwork involved filling in time sheets, material reports, equipment reports as well as making calls to expedite material deliveries. His position does not demand a high level of education, and his functions require very little training. He is required to complete a weekly progress report, weekly time sheets and a report on material received (Figure 3.7). The weekly progress report (Figure 3.6) outlines the daily events as well as the activities of the trades on site. The main purpose for this report is as a record in the event that the architect or the owner proposes changes after the work is completed. The weekly time sheets are used to record the number of hours worked by the firm's men. The reports on materials received and on rented equipment are kept as records of dates materials are received and dates that equipment is received at the site and the date it is returned. There is no report required on a regular basis from the subcontractors; however, if they cause delays or fall behind schedule, they would be asked to submit a report regularly stating the number of men on site and outlining work peformance.

The job superintendent views the biggest difficulty in project control as being caused by change orders. Because of the contractual agreements or the tenant requirements, the plans are revised very often, sometimes even after the work has been done. Especially in shopping centre work, the rental of space often takes place after the plans are made.

3.4.5 Other Personnel

Other personnel involved in project management and control are the foreman and the clerk. The foreman receives the instructions from the superintendent as to the work his crew must do. He then distributes the work, and pushes the men to produce. A crew consists of a maximum of 10 men. The foreman works with his tools along with his men continuously. He is well aware of what each man is doing and each man's capabilities.

3.5 SPECIFIC CONTROL PRACTICES OF THE FIRM

Part of the intent of the questionnaires was to obtain a more in-depth grasp of the control phase of construction projects. Project control implies control of time, cost and content. These variables, however, can be controlled only indirectly since they are dependent on other variables; for building construction these are: cost keeping, scheduling, labour, materials, equipment, construction methods, change orders, subcontractors and physical progress. With regards to these variables, interest lies in the information flow within the company used for control, the processing of this information, feedback obtained, actions taken, and major problems which tend to hinder control. Initially, the author started with the premise that control could be described by way of a systems analysis model which is based on information flow; this is reflected in the questionnaires. However, it turned out that the personnel of the firm do not think in terms of such models. This is consistent with the fact that the firm does not have a procedures manual nor detailed written job descriptions. In this aspect, the interviews proved to be very useful since the focus was redirected to comply with the procedures used by the firm.

The questionnaires had been structured to cover general aspects of control as well as specific technical details. However the systems implemented by the firm are basically rudimentary in nature so that by answering the general questions the specific ones in most cases were also answered. There is little mystery to the process. The firm operates mostly informally, and has little sophistication and complexity. Seemingly the firm has very few problems. Employees did not want to criticize the firm's practices. Therefore it became difficult to identify problems with procedures. Problems with the industry were better identified; however; these cannot be resolved at the project management level.

3.5.1 Scheduling

At tender time the firm quickly prepares a preliminary schedule together with the estimate in order to determine indirect costs and to know the extra cost for construction during winter if applicable. Following award of the contract but prior to construction the schedule is formulated by the estimator in consultation with the project manager, or by the project manager himself. The schedule conforms with the drawings, specifications and estimate. It is in the form of a bar chart containing approximately 30 items which are divided by trades (sometimes trades are combined). In the past schedules were divided into activities when the company executed the work mostly with its own forces. This was discontinued because presently the work is subbed out thus transferring the responsibility to the trades, and because in the past the people who reported information manipulated it to their benefit. The schedule is updated periodically by the project manager or the estimator for the initial part of the project. For the remainder of the work the schedule is seemingly dropped and construction proceeds based on the experience and judgement of the project manager although this judgement is influenced substantially by the exercise of having planned the job in some detail at the outset. An example was given of a $12 million project which was scheduled using an elementary bar chart. It was followed only for the first six months of the 18 month duration of the project. The project was completed on schedule. "Normally the project managers are provided with a starting date and a completion date for a project, and what they do in between is up to them. They do not bother looking at the schedule because they are good practical men"; these were the words expressed by the project manager. The principal reason why the firm discards the schedule part way into the project is the large number of change orders which accompany the type of projects with which the firm is involved.

As stated previously, only one project manager in the firm is familiar with CPM, and occasionally depending on the size of the project he may plan and schedule by CPM. This project manager stated that the use of CPM has helped him to understand a job in a very short time.

3.5.2 Cost Keeping

Cash flow is viewed as the flows of payments of the owner and as such it is important only to him. It is prepared by the estimator in cooperation with the vice president if required by the owner. There is no cash flow done by the firm for its own use to know exactly the receivables and the disbursements every month from every project so that the usage of the firm's capital can be optimized.

Since most of the work is executed by subtrades, it becomes their responsibility to keep their records of costs. Overhead costs, however, are the responsibility of the general contractor. The firm estimates overhead costs based on the duration of the project. Figure 3.8 illustrates a typical level of detail of items for general conditions. The total overhead cost estimated from these items is divided by the number of months, and the resulting amount is added in the form of a percentage to the monthly progress billing to the owner. There is no formal method of monitoring actual overhead expenses. The company does not have a formal cost accounting system. The only cost accounting done is that which is related to the total labour cost to date on a project which is used for payroll. This is obtained simply by adding all the manhours and multiplying them by the appropriate hourly rate. Costs are not at all related to activities; there is no cost control of project activities. Senior management is informed of labour costs to date only by the information available for payroll.

The firm does not fill out any project cost reports other than the claims for project progress payments for the clients and the time sheets for payroll. The progress report includes the value of work done by subcontractors and the value of work done by the firm's own forces. Progress is assessed by visual inspection and computed on a percentage complete basis. The monthly percentage of the total estimated overhead costs is then added. There is no method of knowing the actual costs for each item of work and comparing them to the estimated costs. Only material and labour costs may be calculated since there is a record kept of invoices sent by the supplier for material delivered to the site and time sheets are kept for labour; however these are not activity related.

Since the actual cost reports which exist are not activity oriented they are of little if any use to the estimator. Consequently his only feedback from a project is obtained by an informal mechanism by way of conversations with the project manager, and from his involvement with projects in the capacity of job captain. New estimates are based on previous estimates with adjustments made from the personal judgement of the estimator; rather than being based on actual costs recorded from previous jobs. The estimator suggested that having cost records may be of some benefit to him, but in his opinion this would be a time consuming exercise in view of the constantly changing labour and material prices. He sees the need for keeping updated cost records arising if the firm would be of larger size and would have less interdepartmental communication.

Senior management indicated that the actual labour costs are usually higher than estimated, but that these losses are usually made up in other areas and in the final analysis the company makes a profit on the job. Because of the repeat of business, the firm normally does not encounter problems with progress payments from the client; when the progress payments are received, the subcontractors and suppliers are paid. This procedure is partly responsible for low priority being given to the need for detailed cost keeping by the firm.

3.5.3 Labour

The firm executes 30 percent of the work with its own forces. The nature of this work is general labour, general carpentry and masonry. The firm employs one superintendent who is responsible for all masonry work. He has many years of experience in masonry work mostly obtained through the running of his own business. He is consulted by the estimators regarding the labour requirements for masonry work; he draws up his estimates from past experience and personal judgement on the difficulty of the job rather than by keeping productivity records for labour. At the site, labour is controlled by the foreman and the superintendent. It is assumed that the foreman knows how to utilize his men so as to obtain the most output from each individual. He normally is in charge of a maximum of 10 workers. His responsibility is to assign duties to his men and, since he works with them all the time, push them to produce. The superintendent inspects all operations daily and visually compares the actual progress with the assigned amount.

The only formal reporting done on labour is contained in the weekly time sheets which record the manhours, and on the weekly progress report which records the number of men working on a project daily. The information contained in the time sheets provides the only feedback to the office. This only gives the total manpower picture; there is no divisions as to the number of hours spent in each activity. There is no labour productivity records kept by the firm. Control of labour is done on an informal basis and communication is carried out on a verbal level. The firm relies mostly on the trustworthiness of the superintendents and foremen.

Labour control at the project manager's level is done simply by visual observation. For very large projects one project manager sometimes makes use of an activity chart. Together with the superintendent he lists the various activities that require carpenters and labourers, and assigns to them the number of men required. With the aid of this chart the project manager becomes aware of the manpower needs and distribution. However this chart cannot be used to determine labour productivity or cost overruns because the firm does not have any actual figures to compare with, nor measures output.

The role of senior management in the control of labour is also informal. The vice president may periodically ask the project manager for the number of men engaged in an activity. The project manager may also be asked to cut down on the number of men in order to keep costs down.

One project manager has at times monitored productivity rates of masonry work. He discovered that the actual costs were higher than the estimated costs and that the firm would stand to gain financially if this work was contracted to a subcontractor. The firm, however, executes its own masonry work because quality can be better controlled and this is used as a sales pitch to impress the clients.

According to those interviewed, labour is not viewed as a problem area. This view mostly stems from the fact that many workers, foremen and superintendents have been with the firm for over 25 years and they are very conscientious workers. One foreman believes that having men who have had a long working experience with the firm avoids problems since these men know what is expected of them and produce quality work. Problems with labour occur when the company employ new men. The foreman has to study them for a few days before he feels confident of their performance. When the firm is engaged in work out-of-town and local workers must be hired, their work is limited to the duration of the project and consequently they try to slow work down. The firm is aware of these situations from past experience and takes this into account when estimating future work out-of-town. Even in this case, no formal records are kept.

3.5.4 Materials

Calculations for quantities of materials needed are initially done by the estimator. One copy of the estimate is given to the superintendent at the start of construction. When material is needed it is ordered by the project manager or by the superintendent. Quantities are calculated a couple of days in advance and the request is usually made to the purchasing agent. A record is kept by the superintendent of the material received in the form of a material report (Figure 3.7). A copy of this report is extracted from the delivery slips. Although it allows the firm to know how much material has been used to date, this report does not indicate how much material is still needed to complete the work. There is no formal control of material, and formal control is not viewed by the firm as a priority. Most of the work is subcontracted and subcontractors purchase and provide their own materials. Therefore the only materials the firm is concerned with are those needed for work done by its own forces.

The problem as seen by one project manager is the ordering of excess material and stocking it on site. If more material than estimated is used, it is not discovered until the end of the activity or when the progress billings of the supplier exceed the estimated costs. At this stage senior mangement tries to investigate in order to locate the source of error and possibly make corrections in future jobs. Material delivery dates sometimes cause delays in projects. This is so especially for equipment which requires long lead times for manufacturing. In order to minimize delays, materials for key activities are ordered as early as possible.

3.5.5 Equipment

Most of the equipment used by the firm is rented. The only equipment owned consists of fork lifts for bricks, light trucks and hand tools. The superintendent requests equipment as it is needed. In the case of owned equipment, it is sent to the site on a loan basis, and a record is kept on stock transfer slips by the purchasing agent. Rented equipment is requested 2 days in advance to the purchasing agent who keeps a record of all suppliers and procures from the most convenient one. At the senior management level, the use of equipment is controlled by the secretary-treasurer. He approves all invoices for payment for rented equipment; as such he is aware of the equipment still in use. If he feels it necessary he questions the project manager on the status of work which requires equipment and strongly suggests the prompt return of unneeded equipment. Senior management relies on the knowledge and judgement of the project managers as to the length of time rented equipment is needed. Control of equipment is the responsibility of the project manager. This is done by requesting from the superintendent a formal daily record of the equipment at the site. A copy of this report is sent to the office and can be referred to when necessary. In the opinion of the vice president, project managers become a little lax in returning rented equipment promptly when there is not further need for it.

3.5.6 Change orders

Change orders are initiated by the owners or their architects or engineers and issued by them to the firm's head office. Field change orders are written in the field and signed by a certified representative of the owner. Very often change order work commences prior to the formal issuance of the change order, so as not to delay the job. The contractor is given a contemplated change notice which is an instruction to proceed by the architect or the engineer and then the owner is informed of the cost. The job captain in consultation with the project manager prepares the quotations, gets them approved by the vice president and presents them to the architect or the owner. He also calculates the progress billing for the changes. Normally the owner would pay the requested amount. When there are disputes, however, the quotation is held back until the end of the job at which time a meeting takes place with the owner and agreement, as to price, is reached. On a typical shopping centre project there may be 300 change orders; sometimes this number can reach 500. The total monetary value of the change orders may reach approximately 20 to 25 percent of the total value of the project.

The project manager issues the change orders to the subtrades. In some cases to avoid delay a field change order is issued by the superintendent in consultation with the project manager. This is in the form of a speedy memo. The superintendent sees change orders as the cause of most of the difficulties on the job. Every day he receives revised drawings which he must circulate to the subs involved to make them aware of the revisions. The superintendent's task is made more difficult when revisions come in for work which was previously done because it can prolong the duration of the project. In this case the owner will be charged extra; however the project schedule is disrupted. One other source of problems for the superintendent is the holding of a portion of work by the architect to wait for a forthcoming change. This change sometimes takes up to one month to materialize, and in the meantime the work cannot proceed hence causing delays. The superintendent sees no solution to this problem for two reasons. Firstly, the firm's work consists mostly of building shopping centres and the owners do not know tenant requirements until well into construction. Secondly, on negotiated contracts the owner's objective is to start construction as soon as possible, and as a result the plans are being drawn simultaneously as the building is being constructed.

In answer to the question "what factors, in your experience make the control of cost and time associated with change orders difficult?" the project manager replied, "Lack of proper job costs because of the inability of job clerks to control paper work". He is of the opinion that the present method of change orders cannot change without increasing overhead costs. To him a good project manager and job captain are the key to change order control.

3.5.7 Subcontractors

When plans are ready, bids are called from subcontractors. In the case of public tenders, the firm has little choice; the lowest bidder is usually selected. On negotiated work, the estimators consult the vice president to tell him who the low bidder is and his price; if it sounds reasonable the contract is awarded. The estimator writes the contract and the vice president approves it. Estimates of the value of subtrade work are not always performed by the firm. At the outset of construction the firm meets with the subs. At this time delivery schedules of equipment are obtained from the various trades so that these can be tied to the needs of the job; specific suppliers are asked to submit shop drawings for the approval of the engineer, and the subcontractors are given a starting date and a finish date for their work. The onus is on the project manager to ensure that the subs get to the site on time and perform well.

Much of the control of subtrades relies on the judgement of the superintendent and the project manager. The superintendent daily watches over the work done by subs, and visually observes their performance, sometimes he also counts the number of men the subs have on site. Control of subs consists of the project manager and superintendent pushing them as hard as possible and yelling at them constantly to deliver on time, or to finish their work as soon as possible. If this method is not effective then senior management is made aware and the pushing is done at a higher level. There is no formal reporting on the performance of subs done by the firm at any level. There is no formal reporting required from subcontractors on the progress of the work. Formal reports are demanded by the firm only if the subs constantly delay the job. When written, these reports contain the number of men on site as well as minimal information on the daily progress. Formal control of subcontractors is done by way of the minutes of the weekly coordination meetings. These meetings are chaired by the project manager and attended by the firm's superintendent as well as the foremen of all subtrades on site. The purpose of these meetings is to assign work to the various trades, to coordinate their work and to solve difficulties that they encounter. Minutes of these meetings are recorded and copies are sent to all trades present. These minutes act as proof of promises made by subs and can be later used to make them fulfill these promises. If contractors are not willing to cooperate on the job, the firm delays the progress payment.

The superintendent feels that it is important for subtrades to perform with sufficient quality of workmanship so that other trades that follow have no difficulty in starting. He also feels that his own job may be made easier if the subcontractors submitted to him progress reports. The biggest difficulty by the firm in project control is encountered with subcontractors. This is sometimes due to the fact that the firm has little control over the choice of subcontractor. The project manager believes that subcontractors have a tendency to take on more work than they can handle, thus reducing their ability to perform on a particular job. In order to cut costs subs usually have a tendency to cut corners. This is done by employing foremen who are not qualified, and by trying to leave the site without cleaning up after their work is finished. The firm however insists that subs have good foremen on the job. If the subs do not want to cooperate in doing their own clean up and fixing their own deficiencies, these will be done by the firm's own forces and the subcontractor will be backcharged.

3.5.8 Physical Progress

There is no formal measurement of physical progress and no comparison is made with what is left to do to predict variances in costs. The superintendent together with the project manager at the site assesses physical progress visually. The project manager gives this information on a percentage complete basis to the estimator who adds the dollar value to it. This is done for application for progress payment, and for verifying the amount of work done by the subs for payment to the latter. Formal reporting of progress is done by the superintendent by completing the weekly progress report. Information recorded in this report is very general and the purpose of the report is to keep the superintendent on his toes more than anything else. Senior management receives oral reports from the project manager about project progress not in percentages, but as follows: "He'd say, steel is underway, the erection will be finished next week; the steel deck is scheduled to come in a day later. Masonry is starting the following week." Occasionally the vice president will get involved in estimating the value of the work for progress payment. This way he keeps in closer touch with the project and when the architect questions him about a particular item he can readily answer. The firm does not perform any calculations on cost work left to do, and accordingly it is not aware of cost overruns until the end of the job.

3.6 SUMMARY

Attention has been focussed in this case study on the collection, processing, dissemination and retrieval of information for purposes of project planning and control. An attempt is made in figure 3.9 to summarize the flow of information within the firm for project control. Formal reporting is defined as written information while informal reporting consists of undocumented verbal discussion. Much of the day to day control of a project is executed by way of informal reporting. The written reports employed by this firm are not highly detailed in nature and the job breakdown used for reporting differs for the functions of estimating, planning and scheduling and control.

The main objective of the firm, that of timely completion of projects within budget does not appear to be backed by a formal strategy aimed at attaining it. Based on the interviews held, the company appears to exert reasonably tight control over project time, cost and content largely by informal means - i.e. oral instructions, reporting and follow-up.

Its formal control by way of written reports - i.e. detailed schedule, budgets, progress reporting, etc. can at best be described as loose. Seemingly little attempt is made to ensure uniformity of standards of control between projects and project managers by requiring set procedures to be followed. In fact, considerable accomodation is made for differences in management style.

It would appear that success of the firm could be attributed to the following reasons:

(i) Most of the firm's work is negotiated and consists of repeat business.

(ii) The firm's projects are similar in nature; are not technologically complex; are mainly low rise construction and are of short duration.

(iii) Most of its work is performed in the same market area and it is intimately familiar with suppliers and subs.

(iv) Firm staff have worked together for many years, and are highly experienced in the type of work performed by the firm.

(v) Senior mangement is directly involved in both the managerial and operational control of individual projects and keeps informed by way of frequent oral reports.

As mentioned previously, it was difficult to get those interviewed to identify management problems that they are in a position to influence or to identify improvements in planning and control practices that could be made. Nevertheless, it would seem some improvements could be made as suggested below. The benefit of undertaking such improvements would include:

(i) the potential of taking on a larger variety of projects including those of longer duration and greater technological complexity;

(ii) the establishment of at least a partial mechanism for coping with the transition the firm will undergo in the next few years as its senior, experienced staff retire and new staff are brought on board. This need to provide continuity in the firm could prove to be a major issue;

(iii) the freeing of additional time for senior management for strategic planning as well as allowing project managers more time to concentrate on managerial as opposed to operational control;

(iv) the provision of important feedback to management on project performance in terms of time and cost for use for future projects.

Improvements suggested are:

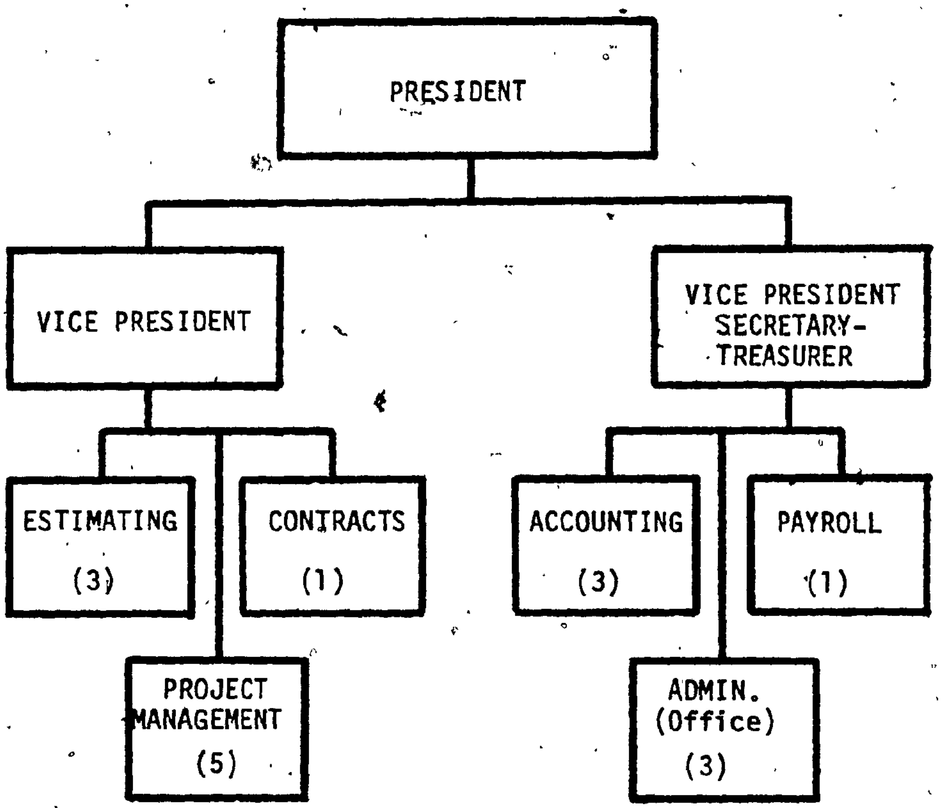
(i) Documentation of roles and responsibilities of personnel and procedures to be followed;

(ii) Integration of project estimating, planning and scheduling and control by way of consistent work breakdowns and activity codes and development of a job cost accounting system;

(iii) In house seminars to emphasize the need of accurate reporting so as to achieve some confidence in the reports made;

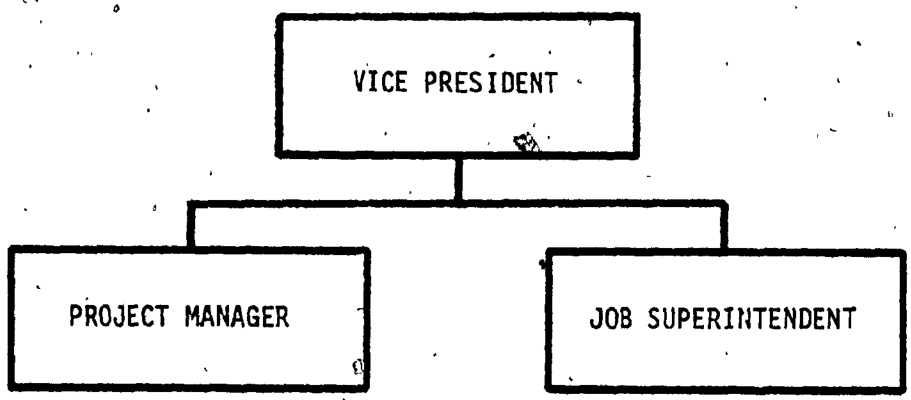
(iv) Development of a subcontractor reporting system to assist in providing greater control over subcontractor progress;

(v) Development of a forecasting system to project cost and time to complete to facilitate prompt action on problem areas.



COMPANY ORGANIZATIONAL CHART

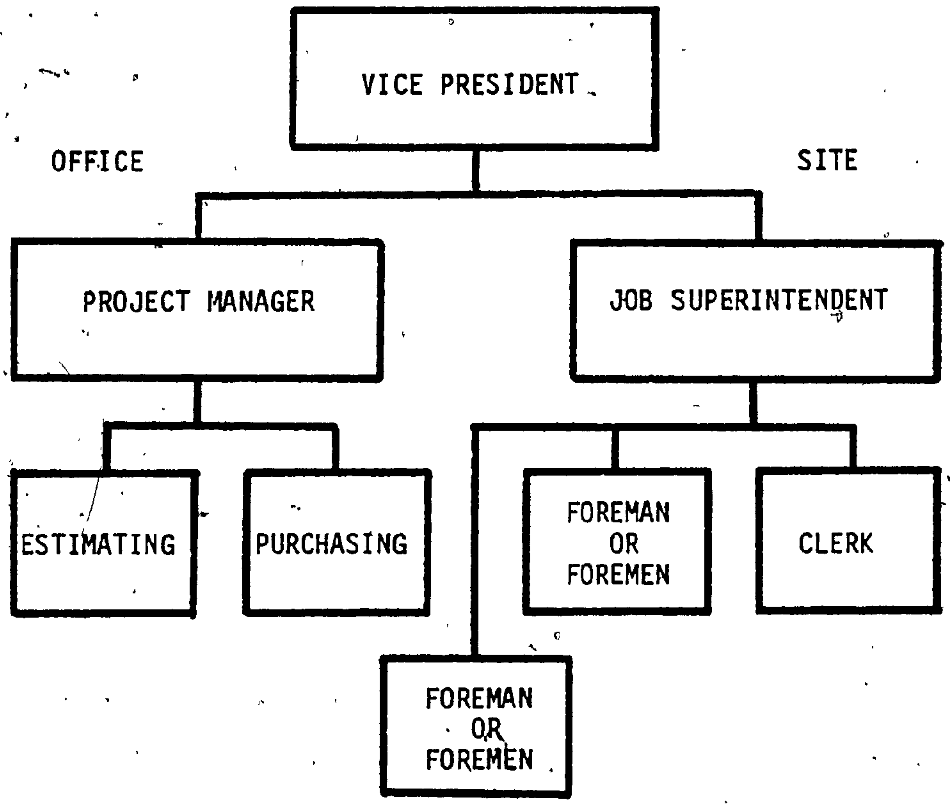
FIGURE 3.1



ORGANIZATIONAL CHART FOR SMALL SIZE PROJECTS
(DRAWN BY VICE PRESIDENT)

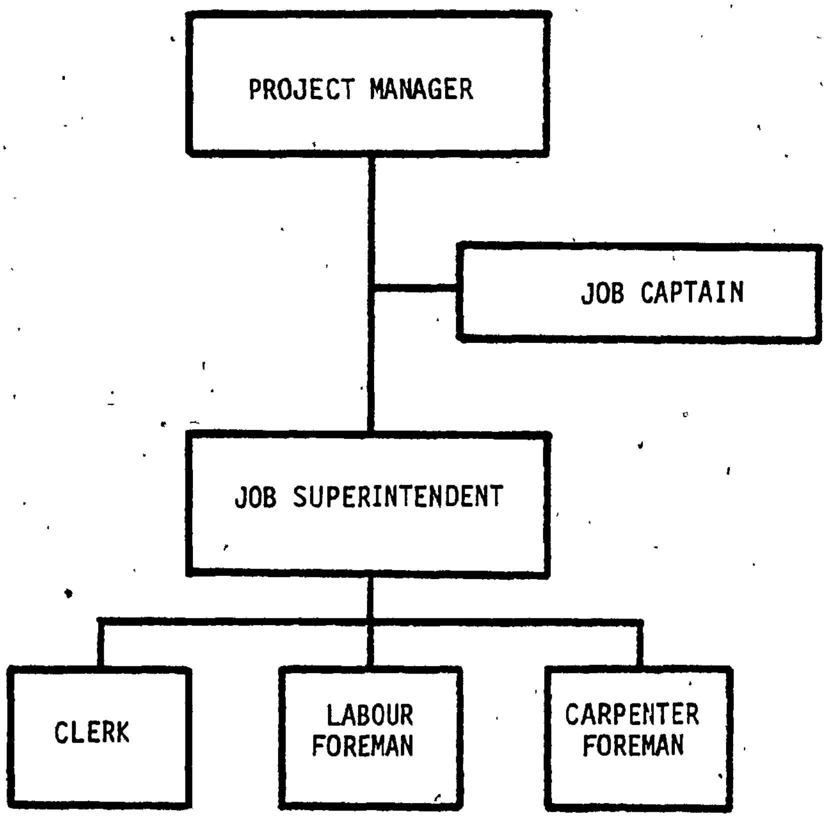
FIGURE 3.2

TYPICAL SITE ORGANIZATION CHART



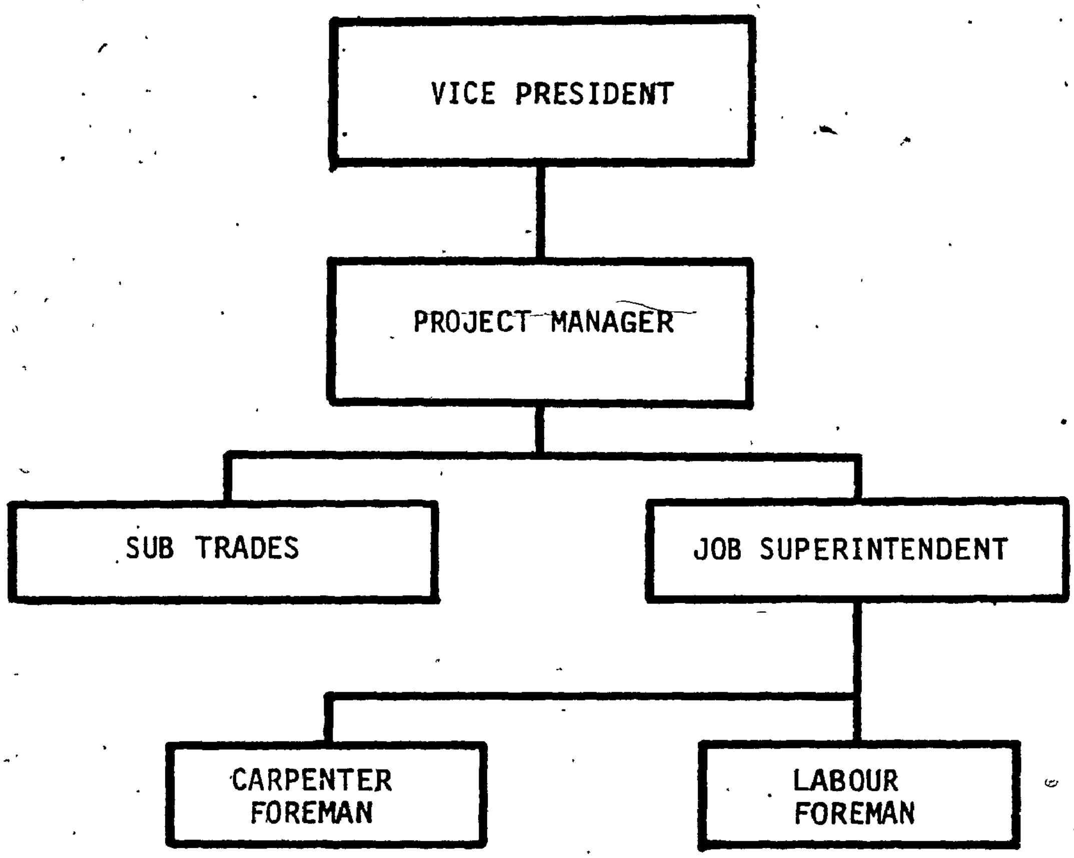
ORGANIZATIONAL CHART FOR MEDIUM AND LARGE SIZE PROJECTS
(DRAWN BY VICE PRESIDENT)

FIGURE 3.3



ORGANIZATIONAL CHART FOR MEDIUM AND LARGE SIZE PROJECTS
(DRAWN BY PROJECT MANAGER)

FIGURE 3.4



ORGANIZATIONAL CHART FOR MEDIUM SIZE PROJECT
(DRAWN BY ANOTHER PROJECT MANAGER)

FIGURE 3.5

WEEKLY PROGRESS REPORT

PROJECT ______________

WEEK ENDING ______________

	MONDAY		TUESDAY		WEDNESDAY		THURSDAY		FRIDAY	
	TEMP ___AM ___PM		TEMP ___AM ___PM		TEMP ___AM ___PM		TEMP ___AM ___PM		TEMP ___AM ___PM	
	CARP LAB MASON MAS.LAB		CARP LAB MASON MAS.LAB		CARP LAB MASON MAS.LAB		CARP LAB MASON MAS.LAB		CARP LAB MASON MAS.LAB	
CONCRETE	C.YDS		C.YDS		C.YDS		C.YDS		C.YDS	
GENERAL WORK IN PROGRESS										
SUBS ON SITE										

FIGURE 3.6

REPORT - MATERIAL RECEIVED

JOB ________________ JOB NO. ________

DATE ________________ SHEET NO. ________

ORDER NO.	DATE RECEIVED	MATERIAL	SUPPLIER	DEL. SUP NO.	REMARKS	OFFICE ONLY

FIGURE 3.7

DESCRIPTION OF WORK	QUANTITY ESTIMATED	ESTIMATED MATERIAL COST	ESTIMATED LABOUR COST
1. PREPARATION			
(a) Layout			
(b) Surveyor			
2. TEMPORARY SERVICES			
(a) Office & sheds			
(b) Light & power			
(c) Water			
(d) Telephone			
(e) Access roads			
(f) Signs			
(g) Partitions			
(h) Fencing			
(i) Toilets			
(j) Safety Railings			
(k) Safety Officer			
3. WINTER CONDITIONS			
(a) Temporary heat			
1) Building			
2) Concrete			
3) Masonry			
4) Basement			
(b) Snow removal			
(c) Winter concrete			
1) Calcium paper			
2) Heated con-			
crete			
(d) Straw			
(e) Tarpaulins			

FIGURE 3.8a - GENERAL CONDITIONS

DESCRIPTION OF WORK	QUANTITY ESTIMATED	ESTIMATED MATERIAL COST	ESTIMATED LABOUR COST
4. SUPERVISOR			
(a) Superintendent			
(b) Carpenter foreman			
(c) Labour foreman			
(d) Clerk			
(e) Watchman			
5. EQUIPMENT			
(a) Hoist & skip			
(b) Hoist operator			
(c) Pumping			
(d) Trucking			
(e) Crane			
(f) Small tools			
(g) Maintenance			
(h) Runs, buggies,			
vibrators, etc.			
6. PERMITS			
(a) Building			
(b) Sewer			
(c) Water			
(d) Sidewalk			
(e) Street or lane			
7. INSURANCE			
(a) Fire			
(b) Public & property			
damage			
(c) Special			

FIGURE 3.8b

DESCRIPTION OF WORK	QUANTITY ESTIMATED	ESTIMATED MATERIAL COST	ESTIMATED LABOUR COST
8. TESTS			
(a) Concrete			
(b) Soil			
(c) Cut tests			
(d) Photographs			
9. CLEANING			
(a) Glass			
(b) General			
10. INTERESTS			
(a) Certified cheque			
(b) Holdback			
(c) Performance bond			
11. OUT OF TOWN EXPENSES			
(a) Travelling			
(b) Room & Board			

FIGURE 3.8c

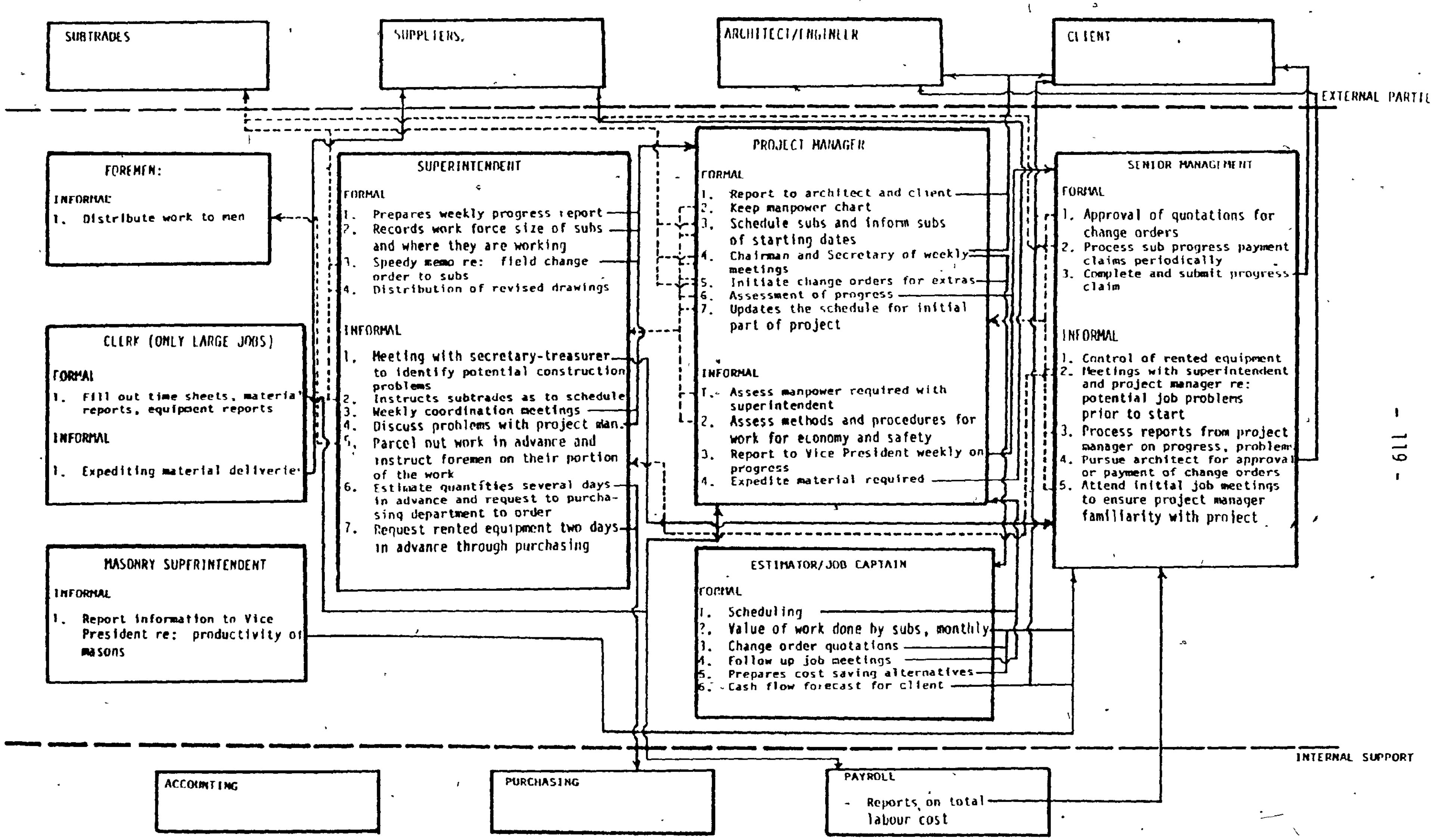


FIGURE 3.9 - INFORMATION FLOW FOR PROJECT CONTROL

CHAPTER 4
CASE STUDY II

4.1 INTRODUCTION

The firm investigated is a successful building contractor based in Montreal. Interviews were conducted with 5 individuals; the secretary-treasurer, one project manager, one estimator, one job superintendent and one assistant superintendent. All interviews were arranged through the secretary-treasurer and they were conducted in private; each individual was unaware of the others' replies with the exception of the superintendent and his assistant who were interviewed together. Senior management did not participate in any of the other interviews except the one specifically pertaining to it. The author and his supervisor from the Centre for Building Studies conducted all interviews except for the one with the superintendent and his assistant which was carried out by the author alone. Interviews took place at the firm's premises, construction site, and at the Centre for Building Studies. They spanned a period of 5 months. The firm granted permission to record all interviews, offered complete cooperation throughout this process, and showed enthusiasm and interest in the research being done at the Centre for Building Studies.

Questions were directed at the identification of roles of personnel at various levels and their attitudes with respect to project management. Emphasis was placed on the collection, processing, retrieval and use of information with respect to the management of individual projects. Questionnaires which are included in Appendix I were used. These acted as a guide to the interview process; they were not rigidly followed. Because the interview process is very time consuming for the firm, there were restrictions on the amount of information which could be obtained. It was found that a detailed interview such as the one conducted was much more revealing than the questionnaire alone and it became clear that since individuals are given a certain amount of flexibility in the way they operate, it would be more beneficial to interview more individuals in order to get a complete picture of the firm.

The reader must constantly keep in mind that the interpretation of the comments are those of the author and his supervisor alone, and they are based on their knowledge of the construction industry. It is also important to note that a slowdown presently exists in the construction industry in Canada; this condition is more acute in the province of Quebec (Refer to Chapter 1). Therefore the present situation is not considered normal and this firm, like many others is working at a slower pace than it used to. Consequently, the firm is fighting for survival in its present form and investigating other markets in order to pick up the slack existing in construction in Quebec.

4.2 CHARACTER OF THE COMPANY

4.2.1 Market

The company is a general contracting firm based in Montreal with branch offices in other cities in Eastern Canada. It is family owned and managed. Its origins date back to 1930 and since then there is an impressive list of buildings in the Montreal area that the firm has taken part in constructing. The company owns other firms which are specialized in one particular type of construction work, and uses their services as subcontractors in construction projects. The firm is also involved in property management and development. These aspects of the firm were not investigated.

Presently the firm operates in Eastern Canada, with an estimated concentration of 80 percent of their work being done in the Montreal area. For the last 4 years the firm has been investigating other markets; these have included bidding for jobs in Western Canada, the Middle East as well as Central America and Central Africa. To date this has been an exercise in gaining familiarity with these markets, since the firm has had no success in obtaining such work. It was not an intent nor objective of the firm to investigate other geographic locations for doing work; however the need to seek such an work arises from the drop in construction work in its traditional market. The secretary-treasurer expressed the belief that there would be no change in this trend in the near future. The yearly volume of the firm presently is approximately $40 million. The firm's volume was some $60 million 3 years back. The magnitude of this decline is principally due to the poor economic situation of the province and is common throughout the Quebec construction industry. Prior to the decline the firm was experiencing a constant annual rate of growth, although the actual rate was not revealed in the interview.

4.2.2 Objectives of the Firm

The main objective of the firm is to maintain a reputation for timely completion of projects within budget. Due to the present slowdown in construction in the province of Quebec, the firm does not set its priority as the achievement of predetermined percentage returns on volume nor a maximization of return on equity. Instead, most of the senior management's efforts are concentrated on ensuring survival of the firm. As mentioned previously, these efforts include attempting to diversify into other geographic locations. Growth at present is not considered an objective, and if present local conditions were stable, the firm would not have diversification as one of its objectives. The secretary-treasurer puts it this way: "We like very much to stay the same size, we don't want to get too diversified nor too big, nor be so many, nor have too much work, because then you lose control and it took many years to build up a staff in order that we could run our operations relatively smoothly."

4.2.3 Organizational Structure

Head office staff consists of 30 people, 15 of whom are clerical staff. Key personnel include 3 senior managers, 1 contracts' manager (who is also chief estimator), 5 project managers, 1 controller, 6 estimators, 1 purchasing agent, 1 safety supervisor, 2 accountants, 6 bookkeepers, 1 paymaster and 1 assistant paymaster. Site personnel maintained full-time include 7 superintendents and 15 foremen. Presently the firm has a total of 130 people on its payroll. Figure 4.1 illustrates the organizational hierarchy of the firm's head office management personnel. Figures 4.2, 4.3 and 4.4 illustrate the organizational hierarchy of the project management personnel involved in small, medium, and large size projects respectively as sketched by a project manager. The firm does not abide by the organizational hierarchy rigidly. In fact, senior mangement strive to have personnel feel that they are part of a family in which they are given both responsibility and trust.

4.2.4 Projects

Today approximately 40 percent of the firm's projects are in commercial construction, 20 percent are in residential construction, 20 percent in institutional construction, and the remaining 20 percent in light industrial construction. Their clients are both private and public entities.

At any one time the firm is involved in approximately 25 projects. Twenty of these are very small in size and 5 are considered major projects. The small projects range in value from $1000 to $200,000; the latter amount being somewhat rare. The duration of these projects ranges from 1 week to 4 months. The small projects account for approximately 2 percent of the firm's yearly volume. These projects are handled by an individual in charge of the small jobs department. The firm performs this type of work because to quote the secretary-treasurer: "It is a selling point". Major projects in general range from $5 million to $55 million and the secretary-treasurer claims the firm is able to handle even larger size projects. The duration of these major projects ranges from 15 months to 36 months. The breakdown of the contractual arrangements for these projects is approximately as follows: 50 percent are on a fixed price basis, 25 percent are cost plus fixed fee contracts, 15 percent are management contracts, 5 percent negotiated contracts and 5 percent are design-build contracts. The design-build contracts usually apply to construction of buildings owned by the firm. The firm estimates approximately 25 to 30 major projects per year; the success rate is expressed by the chief estimator as follows: "We are lucky if we get 2 or 3. If we get 10 percent we are very lucky . . . this number includes the jobs we do on a mangement basis". The firm, nevertheless, is very competitive.

There is no set monetary figure that separates projects into size, nevertheless, a project which is in excess of $5 million is considered large. The firm's profits are almost entirely generated from such projects. Projects whose value is between $400,000 to $5 million are considered medium size projects; the firm however does not get involved in too many of these projects. The chief estimator says "We will occasionally quote a $1 million project if it's a client of ours or it's an architect who asks us to bid. We are not mentally set to quote $1 million jobs".

The firm also gets involved in many small projects. Although emphasis in the interview process focused on large projects, the following information was obtained regarding small projects. These are normally in residential construction and consist mostly of repair work or minor changes or renovations requested by clients of the firm. The existence of the small jobs department is mainly for public relations rather than for generating profits. The average value of small projects is approximately $15,000 to $20,000 and the average duration is approximately 2 months. Contracts are normally on a fixed-price basis. The average work force consists of a total of 20 men who would be working at different times. The average number of workers directly on the payroll of the firm consists of 6 people. The firm executes 30 percent of the work with its own forces and 70 percent is subcontracted. The number of subcontractors may vary from 5 to 10 depending on the nature of the work. The nature of the work done by the firm's own forces consists of millwork and general labour. Small projects have very few change orders and their monetary value is negligible. Job records are kept entirely in the office; no records kept at site.

Large projects, whether they are worth \$5 million or \$50 million are basically managed in a similar fashion. At present the firm is executing 5 major projects at the same time; 3 years ago, that number of projects was 9. In 1978 the firm began construction of 1 major project; in 1977 it began construction of 2 major projects; in contrast it began construction of 5 major projects in 1973. Thus it is apparent that the firm has been adversely affected by the poor economic situation in Quebec. The average value of large projects is approximately \$15 million, and the average duration is 24 months. The normal contractual arrangements are fixed price or cost plus fixed fee; government jobs are always fixed price and contracts with clients in the private domain are negotiated. The work force for these projects is estimated at 200 men at peak. The number of workers directly on the firm's payroll is approximately 25 men. Typically 90 percent of the work is sub-contracted to a total of 30 to 50 subcontractors. The remaining 10 percent of the work is done by the firm's own forces and this consists of general labour and supervision. The average value of change orders is between 6 and 12 percent of the total value of the work.

4.2.5 Project Records

Ninety-five percent of job records are kept at the site and 100 percent in the office; the site is not at all automonous from head office. It is a company policy that no project cost reports be kept on site. All cost records are kept in the office, and all processing is done at the office; the project manager acts as the link between the office and the site. A clerk-of-the-works forms part of the site management for large projects. Duties of this individual include keeping records and preparing reports. Job records which are kept by the clerk at site include:

- time sheets (see Figure 4.5)
- daily labour cost report
- weekly labour cost report (see Figure 4.6)
- summary of monthly labour costs (see Figure 4.7)
- daily progress report (see Figure 4.8)
- subcontractors' daily progress report (see figure 4.9)
- purchase orders completed
- purchase orders not completed
- subcontracts completed
- subcontracts not completed
- minutes of job meetings
- correspondence records

Job records which are kept in the office include all of the above, and the following:

- monthly cost summary
- monthly cost-to-complete report (budget)

Other job records may be kept by the project manager at his own discretion, however these are not required by the firm.

4.3 GENERAL MANAGEMENT POLICY AND PRACTICES

4.3.1 Procedures of the Firm

The company has no policy handbook which spells out the roles and responsibilities of personnel and company procedures to be followed except for a 10 page instruction booklet for record-keeping by the job clerk.

4.3.2 Employee Training

The company does not require management personnel to enroll in courses on construction methods. The reason for not requiring such courses as given by the secretary-treasurer is: "They are better educated on the job site, and I don't believe that you make superintendents or foremen by going to school." The firm does however encourage its personnel to enroll in courses in construction safety. It also enrolled its superintendents in a short metric course offered by the Montreal Construction Association. Generally the firm's personnel have been with the firm for a long time and thus they have adjusted to the roles, responsibilities and authority delegated to them. The attitude of the employees with respect to their relationships to one another and to the firm is similar to that of a large family which enhances the communication process. The employees are very devoted individuals and often they work extra time without pay so that they can get their job done properly.

Although the firm does not have a set formal program for training and upgrading its personnel, it uses informal methods. When hiring new men, the firm puts the individual on an informal apprenticeship program. This consists of performing work as normal, but being closely watched by his supervisors for a period of 2 weeks. The firm upgrades its people according to their capabilities. Junior estimators for instance started with the firm as draftsmen. In 6 out of 7 cases, the firm has had its superintendents come up through the ranks from apprentice carpenter to carpenter, to carpenter foreman, to assistant superintendent to superintendent. An assistant superintendent is a superintendent who can look after a small project but is not yet ready to look after a large project. When the firm hires a new carpenter, it tries to choose one with the potential and capability to become a superintendent. The firm has only 2 engineers amongst its employees, they are both project managers. No one else in the firm has had any formal technical training. Senior managers all have schooling which does not go beyond high school, as do the other project managers and estimators. In the opinion of one project manager, an engineer, "University today and even more in the future will be necessary to construction people because construction is getting more and more complicated". The firm, in the past, hired an estimator who had received a formal education as a quantity surveyor in England; the firm found that he was not a capable person and released him. Perhaps for this reason senior management feels that on-the-job training is superior to academic training.

4.3.3 Motivation

Being a family business the senior management positions will always be held by family members, this leaves little room for advancement to the management personnel. Project managers or chief estimator is the highest position a non-family member can achieve. Rewards are issued in the form of above average salaries and fringe benefits. The firm instills incentives in the personnel by creating a family-like atmosphere, assigning to individuals roles in which they are responsible, and allowing them to make many of their own decisions. Consequently the personnel feel a certain sense of pride in executing their work and in achieving the expectations related to the responsibility bestowed them. The outcome is a team effort and great personal interest in collective success.

4.3.4 Managerial Practices

Project managers of the firm are totally responsible for the execution of a construction project. Their responsibility includes full authority to instruct superintendents and to deal with clients, their architects and engineers, and with subcontractors. They are requested, however, to keep job files on all correspondence and on all reporting; senior management may periodically seek information on the progress of a project and would go through the files. Instructions by senior management to project managers are informal as is reporting to senior management by project managers. Senior management does not get involved in report writing and report reading. In the past the firm had a policy of holding meetings among senior management, project managers, the contracts' manager and the controller. These were held every 2 to 3 months. Here problems encountered by various project managers were tabled, discussed and every one contributed in searching for possible solutions. This meeting proved to be of benefit to everyone involved. However, this practice was discontinued because the firm was awarded contracts for out of town work which required relocating some project managers.

4.3.5 Computer Usage

The firm has an in-house mini computer by Burroughs used for general accounting, job cost accounting and payroll. The machine was installed 4 years ago, and confidence as to its capability was gained gradually by management; in fact in the first year of operations all the computerized reports were double checked manually to ascertain that these were indeed accurate. Time of usage of the computer consists of 2 days for payroll and 3 days for accounting.

For payroll, a set program is used in which the output is recorded directly on pay checks and at year-end on slips declaring total yearly income for income tax return purposes.

For cost accounting, the firm relies on the information documented in the various reports generated at the site. The output is in the form of monthly cost summary reports, and monthly cost-to-complete (budget) reports. The monthly cost summary makes the firm aware of monthly costs of labour, materials and subcontractors for every activity; equipment since it is mostly rented is under materials or subcontractors. The monthly cost-to-complete report compares the actual costs to date for each activity with the estimated costs; this permits the firm to determine variances in actual costs compared to estimated costs for each activity.

The computer also permits the firm to do the invoicing accurately as well as make the firm readily aware of the amount of money owed to any subcontractor even if the latter is engaged in many different projects by the firm simultaneously. The firm can also compare performance of one project to the performance of a previous project which is similar in nature. About these potential uses of the computer, the secretary-treasurer says: "I think it can do a lot more. I think it will take somebody with some time to look and see what it can do; there has got to be more". To date, use of the computer for scheduling and estimating has not been investigated.

Essential to the effective use of the computer is standardization in the reporting system and uniformity in the identification of activities on the part of all levels of management. The firm has assigned specific code numbers to each activity. These codes were devised by the chief estimator and are similar in nature to those in the Appendix II. Reporting from the site with regards to project progress and costs has to be done in accordance with these codes, and progress of each separate activity is determined and reported. To have accurate reports from the computer it is important for site personnel to assign the proper code to each activity. For this reason the firm issues a notebook to the superintendent and clerk of each project to keep at site. This notebook identifies all possible activities and their related codes.

The firm feels that the computer has definite advantages. The accounting department is able to devote much less time to calculations by delegating them to the computer. Benefits derived include increased accuracy and speed. The project manager does not have to apportion time to manual calculations of job costs, allowing him additional time for supervision and control. The firm still generates the same type of information as it did prior to the instalment of the computer, except that now the information is more detailed and it allows the firm more versatility in the manipulation of figures to compare possible outcomes.

The secretary-treasurer is of the opinion that although the use of the computer generates superior reports, it does not replace staff; he says:, "The machine gives us the possibilities of quick modifications as far as reports for our accounts are concerned. However it is not an overhead saving mechanism". When asked what led the firm to adopt the computer, he answered: "Our senior staff including project managers was spending a lot of time doing menial work such as adding and subtracting figures. Records are vital to this industry; there is a lot of looking back on what was done before and this is an exceptional system in that everything is there, literally at your fingertips . . . The first year we had the computer we did everything by hand just to check the answers. Now, whenever we get an idea that will fit into the parameters of what the machine can do, we try it out".

4.4 PERSONNEL

The descriptions of the roles of the personnel interviewed are the author's interpretation of the information received from these five individuals. In defining these roles, emphasis was placed on project planning and control. It is important to note that there is flexibility in the organizational hierarchy of the personnel; senior management, for example, may instruct an estimator on how to perform a certain portion of work without consulting the chief estimator. Members of the firm are not inclined to think in terms of organizational hierarchy. Senior management devotes little time to running individual projects; this task is delegated to the project managers. To identify the roles of individuals with respect to project management, emphasis was placed on the collection, processing, retrieval and use of information. It was discovered that the firm has a well structured information system which is adhered to by all from the project manager down to the foreman. Senior mangement makes use of informal reporting. This firm however is like other firms investigated in that personnel are action oriented; the role of information transfer is mostly delegated to the clerk at site and the computer in the head office.

4.4.1 Senior Management

Ownership of the firm is in the hands of two brothers, the president and the vice president. They are the only ones who determine profit margins and know the firm's profits. The formal schooling of these individuals does not go beyond high school. Their experience has almost totally been obtained from on-the-job training. Their functions are not necessarily related to their titles - in fact they sometimes overlap thus permitting one to substitute for the other. Their roles with respect to project management are somewhat limited to spot checking of construction progress. Reporting done by them or to them directly is mostly informal.

The sons of the president and vice president have shown an interest in the firm, and accordingly are being trained to become the future senior managers. They are being exposed to all aspects of the firm. The son of the president is presently the secretary-treasurer of the firm. He has been with the firm approximately 10 years and has spent much of that time on the construction site. He has already handled his own projects in the capacity of project manager. The son of the vice president is a university graduate in commerce. After ending his schooling he worked in the firm's accounting department for 10 months, after which he went to work on site as assistant superintendent which he has done for 3 years.

Although he has duties to perform and works diligently to fulfill them; his main function is to learn. They have both enrolled in courses in project mangement, CPM, and labour relations.

As it was possible to interview only the secretary-treasurer, a detailed description of the duties of the other 2 senior managers was not obtained. However part of the discussion was directed to the role of senior management with respect to project management. This can be outlined as follows:

- In the estimating phase senior management scrutinizes the estimate prior to submission of the tender with the chief estimator, decides on markup and profit, arrives at final costs and signs tender for submission.
- In negotiations with subcontractors senior management advises the contracts manager on the writing of particular clauses.
- Senior management calls meetings attended by project managers, the chief estimator the controller at which project managers table problems encountered with their projects and everyone contributes to suggesting solutions for solving these problems.
- During construction senior management is immediately contacted in the case of major problems.
- Senior management takes action by communicating with the top management of the client or subcontractors only if the project manager is unable to obtain a satisfactory response

from them with regards to productivity, change orders etc.

- Project managers report to senior management on an informal basis and make the latter aware of construction progress; in addition, every month senior management is provided with the monthly cost summary report and the monthly cost-to-complete report (budget). Every 3 months the project manager completes a cost report projecting final costs by using the monthly cost summary and monthly cost-to-complete report. This is also submitted to senior management.
- Senior management periodically visits the job site; progress is noted and compared with the project schedule and if deemed necessary comparisons are made to previous projects of similar nature.
- Senior management compares the findings from their site visits to the monthly reports they receive. If results are not to their satisfaction questions are raised.
- If senior management does not have time to go to site, it may search the files of the project manager to maintain awareness of a project.
- Senior management may act as project manager if the latter becomes ill.
- Senior mangement is supplied by the estimators with costs of major activities on the basis of unit area (square feet) of building.
- Senior management devotes more time to projects which are financed by the firm.

Other non-project related functions of the secretary treasurer include:

- overseeing the labour, material and equipment in the head office as it relates to general overhead.
- acting as office manager; the controller, who is in charge of the accounting department, reports to him.

Normally, project managers report to the vice president regarding progress of projects; however, there is no sense of rigidity in the firm as such; all senior managers are made aware of project performance. The secretary-treasurer explains the process this way: "If there is anything critical then the phone rings in the president's office, in the vice president's office and in the secretary-treasurer's office. If it's nothing acute but you realize you are a little behind schedule, you go to the project manager and you ask why; I presume because he's on the job and knows the job he will be able to give you feedback. With that you either say that there is nothing you can do, or you start applying pressure at the right places in order to get things moving according to plan". Of major importance to senior management is the money aspect of a project and its aim is to see costs as low as possible. Yet senior management generally devotes little time with procedures involved in project estimating, planning and control. Much of the responsibility in that area is delegated to the project manager and to the chief estimator, these people have, in the past, proven trustworthy and have contributed to the company's success.

Senior management's policy is to make themselves easily accessible to people within the firm as well as outside the firm. That anyone can speak directly to the president without the need for an appointment, is considered one of the major strengths of the firm.

In the opinion of the secretary-treasurer, the biggest problem the company faces presently is that of the decreasing volume of work in Quebec. The firm presently faces possible cutbacks in staff which it is reluctant to do since it took a long time to build up a reliable work force. The major culprit according to the secretary-treasurer was the labour unions which were making high demands thus threatening the private investor's security to the point that private investment presently is almost non-existent in the province. He refrained from commenting on the current political situation. Since the firm is versatile in that it has experience in the construction of a large variety of building types both for the public and private sector, it is not affected by the slowdown in construction to the same extent as other firms may be. However, it is having to bid on jobs it would not normally tender on and is bidding them at cost. With regards to the present procedures followed by the firm for project planning and control, the secretary-treasurer expressed general contentment, and placed emphasis on the experience and abilities of the firm's management personnel as being key components to their success.

4.4.2 Project Manager

The project manager is assigned to a project by the vice president. He reports to the vice president project progress with most of his reporting being done on an informal basis. Once assigned to the project, the project manager becomes in charge.

The project manager is assigned to a project after the firm has become successful in obtaining the contract, although in the estimating phase a project manager is consulted in the formulation of a preliminary schedule for purposes of assessing the general conditions. The project manager is fully responsible for every aspect of the construction project and anyone involved including owners and clients is coordinated by him and communicates with him. When major problems arise for which he feels he needs the backing of senior mangement, he calls on them. The project managers in this firm have many years of field experience during which they have been exposed to all aspects of construction. Two of the firm's project managers are civil engineers. The project managers are normally stationed at the head office and visit the site almost daily. They would normally be in charge of 2 to 3 projects depending on their size and complexity. A very large project normally requires the full attention of one project manager, and depending on the contractual arrangements he may be stationed at the site.

The project manager interviewed is a civil engineer who has been associated with the firm since he was a university student and has worked full time for the firm since his graduation 18 years ago. Other education he has includes attending several evening courses in business administration. Due to lack of time, this programme of studies was not completed. His first full-time assignment was as a project engineer working at the site under the supervision of the job superintendent; in his opinion, he was there to learn. His functions were mostly to lay out the building, check and estimate quantities, check progress of different trades, and prepare reports as to the progress. He was project manager for 3 years during which time he progressively gained more and more responsibility. Following this, he returned to the head office to work in the estimating department where he stayed for the next 2 years. While there he was exposed to all aspects of estimating and the amount of responsibility delegated to him increased with time. The position he was next promoted to was his present one of project manager. The size of the projects he handles varies in value from $1 million to $15 million. He believes that proper planning is a crucial part of the project manager's task; in his words: "Proper planning and coordination to me is the most important thing. If you plan then you control your job. If you do not plan, you lose control and you cannot expect to rectify the situation of job progress overnight". The project manager's main functions as described by himself consist of the following:

- studies drawings and specifications
- studies contracts and discusses with contract manager clauses which may be a source of future disputes with subcontractors
- prepares a project schedule in bar chart form, unless CPM is requested by the owner; updates the schedule as required
- prepares a cash flow forecast for the owner when the latter requests it as to the amount of money the owner has to pay monthly to the firm. The cash flow is updated only when major variations occur during the course of the work, such as strikes
- discusses with owner and suggests possible cost saving alternative
- advises the architect by suggesting changes which facilitate construction without reducing functional aspects of the work, or suggests different materials that would perform better
- approves shop drawings
- acts as chairman and secretary of weekly progress meetings with subcontractors
- acts as chairman of coordination meetings involving the owners, architects and engineers
- approves progress payments for work done by subcontractors
- studies the monthly cost summary report and compares actual costs to estimated costs

- Makes site visits daily, and receives weekly the daily progress reports (Figure 4.8) from the site
- approves all invoices for payment except those for the firm's own labour force which are approved by the paymaster
- applies for progress payment to owner's architect and pursues the latter for the issuance of the certificate of approval for payment from the owner
- pursues the owner for progress payments
- receives information with proper breakdowns from subcontractors concerning change orders, approves them, and sends them to the architect for his approval
- is responsible for the purchase of materials that the firm needs for work done by its own forces
- keeps a file of all job records which is easily accessible to senior management
- prepares the cost-to-complete report for senior management. It is based on the monthly cost summary and monthly budget, and is updated every 3 months
- initiates action if costs-to-complete will be higher than those estimated
- instructs when necessary the clerk, the superintendent and the foreman on the cost codes to be used for particular activities of a project
- attends meetings with other project managers, chief estimator, controller and senior management in which

project management problems are shared and possibly solved

One of the major initial responsibilities of the project manager is the preparation of a master schedule. Depending on the size of the project, he may have a project engineer and/or a job scheduler helping him. The project engineer is an assistant to both the project manager and the superintendent. He is usually a young person with a technical background who is being exposed to construction as training to become project manager. At the moment, however, the firm does not have any project engineers. The job scheduler updates all schedules, prepares sub-schedules off the master schedule, and measures the physical progress with regards to the schedule. He would be employed only in large size projects. The project manager is also responsible for materials that the firm has to purchase for work done by its own forces on a project. The estimating department supplies the project manager with the estimate, and he, in turn, advises ~~the~~ purchasing agent to order the material. Sometimes a list of materials to be ordered by the firm is drawn up. This list is given to the superintendent when it is required. He orders the materials through the purchasing agent.

Since the project manager is placed totally in charge of a project and senior management does not get involved, he is expected to run the projects profitably and at the same time maintain the reputation of the firm by satisfying the client. The project manager summarizes his functions as the coordination, planning and administration of projects. With regards to qualities that a project manager must possess he says, "to me the most important quality of a construction manager is common sense". In his opinion the strengths of the firm with respect to project mangement lie in the uniformity of the reporting. He says: "The strength of the cost reporting is that everybody is on the same wavelength". However one of the weakness is the difficulty for site personnel to assign the proper cost code to the activities; if coded wrongly, the cost codes are meaningless. The project manger suggested that in order to keep the clerks, the superintendent and the foremen aware of the proper use of cost codes, the firm should have a 3 hour lecture every 3 months on cost coding, to explain, answer all questions and have the individuals communicate to one another. This has never materialized because of the lack of time available on the part of these individuals.

4.4.3 Chief Estimator

The estimating department consists of 7 people; this includes 1 chief estimator, 3 senior estimators, 1 intermediate estimator, 1 junior estimator and 1 secretary. The role of the estimating department is to arrive at cost estimates to be submitted when the firm bids for fixed price contracts and to prepare budgets using only preliminary sketches in negotiated and management contracts. During the estimating phase, the department will formulate a preliminary schedule with the aid of the project manager to help price the items of work. Once the contract is awarded, the final schedule is prepared by the project manager. The estimating department also assigns code numbers to each item in the estimate; these are similar in nature to those in Appendix II. These items along with their codes are later entered into the computer. Under normal circumstances the estimating department estimates approximately 25 projects per year; on a good year this number can reach a maximum of 40. The time required to perform an estimate is approximately one month with an average of 2 people working on it. For a management contract however, the time required of the estimator may reach 6 months. The success rate was not stipulated with exactness, however if the firm obtains 2 or 3 contracts per year it is considered very good; a success rate of 10% is considered excellent. Some years, however, the firm has had no success.

Details on the estimating department and its role with respect to project planning and control were obtained by way of interview with the firm's chief estimator who is also the firm's contracts manager. He is a high school graduate who attended evening courses in estimating at a university for 2 years. He has 27 years of construction experience, the last 20 with the present firm. He worked as a quantity surveyor for 4 years assigned to cost control. He was then promoted to junior estimator and with time to senior, then to chief estimator until recently when he also took on the responsibility of contracts' manager. The other estimators in the firm have gone a similar route, in that they have high school education and evening courses along with their many years of work experience. The junior estimator started with the firm as a draftsman; the chief estimator tries, whenever possible to develop his skills. There is no program in the firm, however, geared at exposing estimators to the construction site; the chief estimator expressed the reason for this as being related to the size of the firm which is not large enough to allow such an expense for employees to learn. The duties of the chief estimator include the following:

- makes all decisions concerning the running of the estimating department.
- distributes the work to estimating department personnel. However, due to the flexibility of the firm senior mangement sometimes deals directly with estimating personnel.
- spot checks for possible omissions in the estimate just prior to submission and finalizes costs together with senior management; the latter decides on final prices.
- assigns the cost codes to every item of work in the estimate.
- once the contract is awarded, he negotiates the contracts with the subcontractors and suppliers in his capacity as contracts manager.

Of the four senior estimators, one will normally be assigned to a project. He is responsible for completing the estimate for that project and will be linked to the project until the end of construction; this implies that he will be responsible for estimating costs of change orders during construction. To help him during construction the intermediate estimator, an elderly fellow, checks the estimate and calculates extensions, and the junior estimator performs standard quantity take-offs. The senior estimator's functions include the following:

- become familiar with plans and specifications
- list subtrades the firm intends to invite to bid
- send invitations to subcontractors for submission of prices
- prepare a preliminary schedule with the aid of a project manager (not necessarily the one who will be given the project if the bid is successful)
- carry out quantity take-off for items of work performed by the firm's own forces and for items subcontracted on a unit price basis - and price out the tender including the overhead costs.
- once the firm is awarded the contract, prepare a list of all major contracts with all the information which pertains to each job.
- analyze in the specifications the scope of the work of every subtrade to prevent any duplication
- cost the changes during construction
- review the monthly cost summary reports to compare estimated costs with actual costs.
- record actual costs and schedule after the completion of the project to use for future estimates.

- calculate costs per unit area for major items of work and supply a copy to senior management.

As stated previously, the firm subcontracts approximately 90 percent of the work for large projects; most of the contractual arrangements with the subs are on a fixed price basis. Consequently the estimating department does not calculate any quantities and costs for work done under these types of contracts. Quantitites, however, are calculated for all other work. The department also deals with suppliers of materials needed for the project but not with material which the firm buys in bulk. When the firm is involved in the tendering of a large project, the whole department becomes involved in preparing the estimate. The same enthusiasm and diligence goes into the preparation of all estimates the department makes, regardless of size and number of projects running simultaneously. The chief estimator puts it this way: "Whether we become overloaded or not, I'm going to figure a job the way we are going to get it; otherwise it becomes only an exercise. Who needs the exercise?" He considers estimates for management contracts as presenting little challenge for the estimator since there is no competition on the part of the firm. In estimating work done on an upset price basis, the estimate is based on schematic drawings and is performed with more caution. He feels that the personnel in his department are hardworking and very conscientious individuals; they take pride in their work and at times work harder than asked to. The turnover of personnel over the years has been low.

Once the contract for a project is awarded the estimating department provides the project manager with the estimate and the list of subcontractors, and codes and computerizes the cost items. The computerized system imposes on the firm the use of only one code to identify estimates in the planning, estimating and control phases of a project, which must be adhered to company wide. Says the chief estimator: "My breakdown is the same as the machine's breakdown, and the same as the project manager's breakdown. It has got to be, or else it will not work." However, he pointed out that some difficulty is encountered in the assigning of the proper codes to the activities by site personnel; erroneous reporting from the field reduces the reliability of the information received and the effectiveness of the estimators in estimating future jobs. There are no other problems regarding feedback from the field; the monthly cost summaries are sufficient for estimating. Another difficulty encountered by the estimating department is to correctly forecast the material costs many months in advance, due to today's rapidly growing prices. The chief estimator added that part of the functions of this department should be to gather information on project cost performance and process it in order to be useful to all of management. This exercise is difficult because of the lack of free time; sometimes the estimators do this on their own time. However the use of the computer as a time-saving mechanism, in the calculation of extensions, or costs per unit area, has not been investigated. Further, the use of the computer to process job cost data in a manner directly useful for estimating future jobs has not been examined.

4.4.4 Job Superintendent

A job superintendent is assigned to every project, he is stationed at the site and is responsible for all field operations. He supervises the men, coordinates the trades, approves the quality of the work and handles the day to day problems. He is usually able to work with levels and to lay out lines. He is often a former carpenter; accordingly he is able to make minor adjustments in the finishes towards the end of construction once all the work force is gone. The superintendent interviewed has 32 years of construction experience; he started at the age of 16 working for a general contractor as an apprentice carpenter in residential construction. Since that firm executed most of the construction work with its own forces, he became exposed to all aspects of carpentry. At the age of 25 he enrolled in evening courses in blueprint reading and estimating. He has been superintendent for 20 years, the last 7 with the present firm; he is the only superintendent who has not come up through the ranks of the firm (since he was hired as superintendent). A typical project he handles has an average value of $7 million and an average duration of one and a half years. For these projects, the average number of workers of the firm is 15 at peak, and the maximum number of subcontractors at the any one time is 18. His main functions can

can be outlined as follows:

- follows the schedule at site, and if one activity is delayed, determines its effect on the progress of the project
- ensures that the work is done according to plans and specifications
- parcels out work determining the priorities and instructs the foremen as to the execution
- coordinates all subtrades so as to prevent any delay in the work; the subtrades are directly responsible to the superintendent at the site level
- prepares weekly work schedules for the subtrades and requests from them daily progress reports. If work is delayed, meets with foremen of the subtrades to return the project to schedule
- if a subcontractor refuses to do a portion of his work, the superintendent instructs his men to do it, and later backcharges the subcontractor for that work
- advises clerk to rent equipment when needed, and tries to keep equipment on site as little time as possible
- measures the amount of material needed for work to be done by the firm's own forces, and advises the clerk to order
- attends coordination meetings with the subcontractors, and meetings with the owners and architects which are called by the project manager
- approves work codes used by foremen for work done by their

men

- seeks permission from the project manager before proceeding with work on a change order.

The superintendent personally devotes approximately 15 minutes each day for writing reports; the clerk completes most of the formal reports. The report completed by the superintendent himself is the daily progress report (Figure 4.8). The superintendent's main concern is production at the site, which means preventing any deviations from the schedule made by the project manager, at the same time ensuring that the work is done according to the plans and specifications. The superintendent is directly responsible to the project manager. The latter would visit the site almost daily to visually measure progress, and informally give feedback to the superintendent on plans of actions. The project manager sees the most important function of the superintendent as consisting of pushing the work so that the project is constructed according to schedule. The superintendent interviewed sees his most important function as being the coordination of subcontractors, architects and engineers as to minimize problems.

Also interviewed in this firm was an assistant superintendent who is the son of the vice president of the firm. His background consists of a university degree completed in commerce 4 years ago, 10 months with the firm's accounting department and assistant supervisor at various sites until the present. He appears to be following an apprenticeship program to train for future senior management. At the site his work consists of checking the finishes and listing deficiencies, pursuing sub contractors, calling suppliers to expedite material deliveries, and recording the progress of work on the site schedule which he inspects visually. His official duties, however, are not those of a clerk. He believes that the system of supervision of subcontractors in construction is unsatisfactory in its application. On site the superintendent constantly has to keep after the subcontractors in order to get good work from them. However, he claims that his firm has very satisfactory control with regards to supervision and to costs because in his words, "the way our company is run is sort of with an iron fist". He also says, "from what I have seen, in construction money talks and people listen when you are talking about money." The schedule that the firm's personnel follow at site is in the form of a bar chart; this poses no problems in the understanding of it. With respect to the reporting done at the site, he believes that all the reports are necessary. He admits however that at times difficulties are encountered at the site with respect to interpreting the cost codes and appropriately assigning a code to each activity.

4.4.5 Other Personnel

Other personnel involved in project management and control are the foreman and the clerk-of-the-works. In most jobs the firm would have 1 or 2 foremen, or very often one foreman and under him a pusher. The pusher is a labourer or carpenter who works with his tools and at the same time pushes the men working for him. The foreman keeps a book where he records the hours for each activity worked by each of his men. Since the foreman is in charge of 5 to 10 men and the codes of the activities on which they work are known to the foremen, he records the codes himself. Throughout the day the foreman keeps track of where his men are working, and depending on the nature of the project and some of his crew he may work with his tools rather than just supervising. The foreman discusses daily with the superintendent, the men, material, and equipment required for the day's activities and information is exchanged as to the progress of the work. At the end of the day each foreman supplies the clerk with the description of various operations completed during the day by employees under his supervision, and the number of hours worked by each employee on each individual operation.

Present on every major project is the clerk-of-the-works who handles most of the reporting and record keeping at site. One of his main functions is to relieve the superintendent of the paperwork. The firm keeps a 10 page booklet which spells out the exact duties of the clerk. The clerk may be under direct supervision of the job superintendent or the project manager. However he is under the directive of the paymaster for information which is supplied to the payroll department, under the directive of the purchasing department for material and equipment ordering and delivery, and under the directive of the accounting department for costing procedures and other matters pertaining to accounts payable. The clerk's regular hours start 15 minutes before the workers start and end 15 minutes after the end of the working day. His duties consist of time keeping, costing, and material and equipment ordering and recording. He records on time sheets (Figure 4.5) and time books the names of the men on the job and number of hours worked. These are made in duplicate except for those for cost-plus work which are done in triplicate. At the end of the week the clerk adds all the hours and multiplies them by the applicable wage rate thus arriving at a total which must match the total of the weekly labour cost report (Figure 4.6). He signs all time sheets and gets them approved by the superintendent. With regards to costs the clerk completes the daily labour cost report, the weekly labour cost report (Figure 4.6), and the summary of monthly labour cost (Figure 4.7). With the aid of the information he receives from the foreman he assigns a code number and a cost to each operation.

Daily, the clerk records in a journal the material he receives at site and assigns to it a cost code as to where the material will be used; this is matched to the quantity control. Also recorded is the date that the material is received, the quantity received, the delivery slip number and the supplier. The clerk distributes tools to workers and records all transactions so that all tools are accounted for. When rented equipment is received on site, the clerk is to state the condition of the equipment as well as the date and hour of receipt and return of the equipment. Monthly he carries out a physical check for equipment and tools at the site and reports findings to head office. The superintendent normally completes the daily progress report (Figure 4.8). However, at times this duty is given to the clerk in which case the superintendent signs it for approval. The clerk is also in charge of keeping site files of all reports, documents and/or correspondence previously described.

It is very important for the firm to define the functions and procedure of the clerk quite closely since many reports fed into the computer are dependant on information provided by him. Thus he becomes a key character in the firm's project information system. The use of the computer implies that all information must be uniformly recorded; although this implies rigidity in the mode of reporting it also provides clarity of presentation of information. The clerk must be able to understand fully the firm's coding system and implement it correctly for proper project progress control.

4.5 SPECIFIC MANAGEMENT PRACTICES OF THE FIRM

Part of the intent of the questionnaires was to obtain a more in-depth grasp of the control phase of construction projects. Project control implies control of time, cost and content. These variables, however, can be controlled only indirectly since they are dependent on other variables; for building construction, these are: cost keeping, scheduling, labour, materials, equipment, construction methods, change orders, subcontractors and physical progress. With regards to these variables, interest lies in the information flow within the company used for control, the processing of this information, feedback obtained, actions taken, and major problems which tend to hinder control. Initially, the author started with the premise that control could be described by way of a systems analysis model which is based on information flow; this is reflected in the questionnaires. However, it turned out that the personnel of the firm do not think in terms of models. The interviews proved to be very useful since the focus was redirected to comply with the procedures used by the firm.

The questionnaires had been structured to cover general aspects of control as well as specific technical details. However the systems implemented by the firm are basically rudimentary in nature that by answering the general questions many of the specific ones were also answered. Although the firm operates with more formality than the others investigated, much of its control is done on an informal basis. Seemingly the firm has very few problems with respect to project control. Employees did not want to criticize the firm's practices. Therefore it became very difficult to identify problems with procedures. Problems with the industry were better identified, however these can not be resolved at the project mangement level.

4.5.1 Scheduling

At tender time the firm prepares a preliminary schedule in order to estimate indirect costs and know the extra cost of construction during winter. This is usually prepared by the estimator in consultation with the project manager. Sometimes records of previous jobs are consulted. The chief estimator claims that due to the expertise of the firm, the preliminary schedule corresponds closely to the actual duration of the project. Following the award of the contract but prior to construction, the actual master schedule is formulated by the project manager assigned to construction. Sometimes it may take weeks for him to study the plans and specifications and arrive at a schedule. The schedule is in the form of a bar chart which contains approximately 50 activities but may have up to 80 for a very large project. When finishing dates are provided by the owner the schedule is formulated to comply with them, otherwise the firm relies on schedules from previous jobs. The breakdown of the schedule is divided into activities which reflect the cost codes. This is similar in nature to but less detailed than the estimate. Detailed sub-schedules consisting of approximately 50 activities are formulated for each major activity in the master schedule, depending on the importance of the activity; time units of one half days are used so that operations can proceed like clockwork. A sample of a sub-schedule for finishing work alone on a $4 million project was shown; this contained approximately 200 activities. It should be noted that the schedule is more detailed than the cost coding.

The firm is generally opposed to the use of CPM for scheduling and will use it for its projects only when requested by the owner. Even in those cases the schedule is converted in barchart form for use at the site. The firm feels that CPM at site cannot be used because both the firm's superintendents as well as those of the subcontractors' have difficulty understanding it. An example was given by the secretary-treasurer of a project for which the client requested a CPM schedule and engaged outside consultants; these would take the information from the firm's bar chart to formulate their schedule. The firm has a CPM expert, however he has not formulated a schedule using CPM for the last 3 years; he is presently in another capacity. The firm views CPM as a tool more beneficial to the owner than to the builder. The firm usually uses its own staff to prepare a schedule. In the past 25 years it has used the services of outside consultants at the most 10 times, this only for the cases where the schedules required the use of CPM. Updating of the schedule is done by the project manager except for very large projects to which a scheduler is assigned. The scheduler updates the schedules and prepares sub-schedules from the master schedule. He prepares a progress report with regards to the schedule. He interacts with subcontractors in matters of scheduling only in that he will ask the various trades the amount of time required to perform a certain activity. He reports all information back to the project manager. The scheduler will visit the site, record progress and report findings to the project manager weekly or monthly depending on the nature of the project and on whether or not it is progressing according to schedule. The frequency of the updating ranges from weekly for small projects to every 3 months for very large projects. Since approximately 90 percent of the work is subcontracted, the project progress is largely dependent on the progress of the subtrades. This progress is scrutinized by the project manager at the co-ordination meetings with the subcontractors. Here the schedule is reviewed; questions are posed regarding difficulties in meeting time requirements and advice is given by the project manager in order to help the subcontractors maintain their schedules.

At the site the schedule is followed and progress is recorded in the bar chart. The superintendent monitors activities to ensure that they are completed according to the dates stipulated in the schedule. Since the schedule is in bar chart form, site personnel have few problems in interpreting it, however, problems may sometimes exist in following it. For this reason, the superintendent must foresee if the delay of one activity will cause a delay in the project, and has to push the subcontractor as much as possible to follow the schedule. In fact the firm sometimes uses 2 schedules, one to show the subcontractors and one which is the real schedule. When asked about the importance of maintaining a proper schedule on site, the assistant superintendent replied that the schedule is considered a Bible. The measurement of progress at site is done by the superintendent or his assistant, simply through visual inspection. This is recorded on the bar chart itself. These words were voiced by the assistant superintendent: "Basically we give a percentage of what has to be done. We have to be accurate in our assessment of the work completed with good quality". If it is not in good quality, the firm does not consider it completed.

4.5.2 Cost Keeping

The accounting department is responsible for the general accounting as well as the job cost accounting. This is done with the aid of the computer. The job cost accounting is divided into activities each one having a distinct code number assigned to it by the chief estimator when putting the estimate together. Labour cost and payroll are kept separately and are calculated independently. Cost reports for labour are prepared weekly at the site by the clerk, and are totalled monthly according to each cost code; overhead costs are coded separately from other costs. These reports are prepared independently of the time sheets which are completed daily and totalled weekly and monthly for purposes of payroll. Weekly and monthly, the resulting amounts from the time sheets are matched with the costs of labour. The clerk also assigns a code number to the materials received at site. All information is sent to the office by him weekly; here it is entered into the computer for processing. Other information entered into the computer is obtained from the applications for progress payments by the subcontractors which have received approval by the project manager, and the vouchers prepared by the project manager for payment of rented equipment.

The computer outputs a monthly cost summary and a monthly budget for every project. The monthly cost summary provides the monthly costs and the total costs to date for every activity which has a code number attached to it. The monthly costs are divided into labour costs, material costs, and subcontract costs; rented equipment is included either under the material or subcontractor costs. There is no information on mark-up on this report. Copies of the monthly cost summary are sent to senior management, the project manager and the estimating department; if requested a copy is sent to the site, however in keeping with company policy of not keeping any cost project records at site, the monetary value is removed. The monthly project budget compares the actual costs to date of each activity with the estimated costs of those activities. Especially in the cases when activities are completed or close to completion the firm is able to know whether it has come under budget or over budget, and the actual variances are measured. If actual costs of an activity are higher than estimated, then the firm can take action in trying to save costs for future activities so that it does not incur lower profits or losses on a project. The firm has no way of projecting the costs of activities. Thus it is unable to take action at the initial stages of activities whose forecasted cost is higher than the estimated cost. Costs of change orders, once approved, are included into the estimated cost thus making it higher. Using the monthly cost summary the invoicing by the firm is done by computer. The project manager says: "The strength of the firm's cost reporting is that everybody is on the same wavelength". However he also expresses a possible weakness in the system as being related to the difficulty on the part of site personnel in assigning proper cost codes to activities which may lead to misleading results.

The firm uses the job cost accounting information to generate a monthly financial statement. This is drawn up by the controller; it includes all operations of the firm and it is not computerized. However, the firm claims that the big money is made from the construction projects. Senior management claims that cash flows are not important to the firm and are not done on a regular basis as the firm has no difficulty procuring cash. At the request of clients, the firm performs a cash flow analysis for individual projects in order to allow the client to know the financial requirements he must meet. The cash flow is never revised drastically unless there are major changes in the schedule due to strikes or very late material deliveries. For every project at 3 month intervals, the project manager prepares a cost-to-complete report for the vice president; and the estimating department prepares costs per unit area for major activities once the project has been completed which serves as a record for estimating future work. However, neither of these reports are computerized.

4.5.3 Labour

The firm executes 10 percent of the work on major projects with its own forces which total 120 men. The nature of this work as outlined by the project manager consists of: pumping; temporary elevators; material hoists and man hoists; supervision; cleaning; temporary heating of concrete; snow clearing; batter boards; hoarding and protection; sidewalk covers; excavation and backfilling; laying down a form tile; rough carpentry including blockings for windows and roofs; concrete finishing and repair.

Control of labour is done at the site visually by the superintendent and foreman in writing by the clerk. Control by the superintendent and foreman consists of supervision and motivating the men to produce. Control by the clerk consists of collecting information from the superintendent and foremen and completing and assigning work codes to time sheets and labour cost reports which are sent weekly to the office for processing. The firm's labour force generally consists of hard working individuals most of whom have been associated with the firm for over 20 years. Therefore the firm has no major problems with labour productivity. However due to the labour problems in the past few years and union regulations, even their productivity has decreased. Senior management feels that the general decline in productivity of labour in construction is indeed a major problem for the firm because unrest has caused many private investors to leave the province thus reducing the quantity of construction work. Due to new regulations, workers have to be hired through union halls, this results in the firm having no choice of men when hiring new workers. Presently due to the shortage of work the firm has no problem with productivity. As mentioned earlier, one other problem in control of labour lies in the difficulty on the part of field personnel in reporting the information implementing the work code. To alleviate this problem, the project manager suggests: "What we should do is every 3 months gather together all the superintendents, foremen, and clerks for a 3 hour refresher course on cost coding and have them communicate with each other." However he also indicated that this gathering is very difficult to arrange because of the lack of free time.

4.5.4 Materials

Calculations for quantities of materials needed are initially done by the estimating department who deals with suppliers to inquire about their materials and also assigns the code numbers. A copy of the estimate is given to the project manager who then becomes responsible for the materials that the firm must purchase. The materials purchased by the firm are for work done by its own forces; the subcontractors supply their own materials. The project manager advises the purchasing agent to order the materials. The latter prepares a purchase order and gives 1 copy to the project manager who records it as to what the material is, its code number and the date it is required, and one copy to the superintendent. When the superintendent needs the material at the site he calls the supplier who already has a purchase order and asks him to deliver the required material by a certain date. What is done sometimes is to prepare a list of the material needed, this is given to the superintendent and he would order the material when he requires it. Therefore all purchasing and expediting for a project is done by the project manager, the superintendent and the clerk; for the purchase of building materials in bulk the responsibility is delegated to the purchasing agent. Control of materials at the site is mostly done by the clerk. The firm requests that suppliers have delivery slips when making material deliveries. This way the firm is able to know the material received even though the supplier may not have sent the invoice. The clerk assigns code numbers to the delivery slips as to where the material will be used and keeps a record of the material received matching the amount to the total material estimated. Recorded daily in a journal is the material received at site along with the date received, the supplier's name, the quantity, and the total quantity to date. According to the project manager the firm's control of material is satisfactory. Problems sometimes are encountered with delivery dates; the firm has no control over that except to keep on calling and pushing the supplier. The project manager considers theft to be the biggest problem encountered by the firm in the control of materials. Theft is dependent on the location where construction takes place; in some locations theft does not present a problem at all.

4.5.5 Equipment

Most of the equipment used by the firm is rented from a company it owns and is charged to the project. The only equipment owned by the firm consists of light trucks and hand tools. When equipment is needed, the clerk is advised by the superintendent one day in advance and calls the supplier. When equipment is received at site the clerk records the date and hour the equipment was received and its condition; a similar procedure is followed for return of equipment The clerk distributes tools and ensures that all tools are accounted for. He also maintains an up-to-date inventory in a ledger for all tools and equipment along with the serial numbers where applicable. This must match the equipment recorded in the shipping and receiving slips. The superintendent controls equipment visually as to the amount of time it is being used. The project manager monthly prepares a voucher to pay the equipment suppliers, therefore he is aware of equipment at the site and his concern is to ensure that equipment is returned immediately after its need has ceased. Over the years the firm has discovered that unless there is proper control people tend to forget to return rented equipment when no longer needed, and to take good care of tools since they are not their own. Monthly, the clerk carries out a physical inspection of equipment and tools at site and formally reports to head office the details of the findings. On the monthly cost summary cost of equipment is reported under materials or subcontracts. The secretary-treasurer feels that the amount of equipment the firm owns is sufficient for its uses. The firm cannot justify the purchase of more equipment because the usage will always be less than that of a subcontractor who specializes in a certain type of work. Therefore the firm will be less competitive if it has to amortize the capital cost in the same amount of time.

4.5.6 Change Orders

Normally the procedure of issuing change orders is the following. A contemplated change notice is sent to the firm by the architect. When the firm receives it, it channels it to the different subtrades that are involved in the change and requests from them a quotation with a breakdown as to what are the quantities and costs. If there is any involvement by the general contractor, then the firm prices that portion of the work and includes it in the whole estimate. The project manager gathers all the information and sends it on to the architect for approval. If the changes involve structural, electrical or mechanical work, then that portion of the estimate is sent to the consulting engineers involved. They give their approval and inform the architect. The architect then issues a change order which is chanelled through the consulting engineers for approval. It then gets final approval by the owner and finally it goes to the firm for execution. The firm, in turn, sends change orders to the subcontractors that submitted a quotation and they proceed with the work. This is a very lengthy procedure and most of the time the work starts before all the paperwork is sorted out; however, there are owners that do not permit any change order work to get done prior to their approval. In most cases, this procedure is accelerated. Before issuing a contemplated change notice, to the general contractor, the architect sends it to the owner for approval; this way he is made aware that extra work is involved. Normally the owner will authorize the firm to proceed with the work, so as not to hold up the job, even though quotations have not been submitted. The subcontractors are made aware that when they submit a price, they will not necessarily get paid the amount they stipulated in their estimate. Once the paperwork is all submitted, issues are discussed and negotiated by all parties involved. Change orders are sometimes initiated by the architect who issues a field order while at the site authorizing the firm to proceeed with work which is not covered in the scope of the contract. The firm starts the work immediately without waiting for the procedures involving the paperwork. At times, due to the uncertainty of the cost involved in the change order, work is done on a time and materials basis whereby daily slips of time and equipment are signed by representatives of the firm and of the architect. Normally the total value of change orders is 6 percent to 12 of the total value of the firm's major projects.

With respect to change orders the role of the estimating department is to price the work, issue the change orders to the subcontractors, cost report by adding the cost of the change to the original cost of the activity. The project manager is responsible for soliciting the owner for approval of the change orders. Senior management's interest in change orders is only in expediting their issuance from the owner if the project manager is not effective. A drawback in the system of change orders with the firm existed in their method of approving invoices from subcontractors for payment, knowing that the work was done but without having issued a formal change order to the subcontractor. Later when the change order was issued the subcontractor would give the document to the controller who would bill the firm a second time. In some instances this invoice was approved by the construction manager since he may not remember having approved it the first time. In effect the firm paid the same invoice twice. The firm has eliminated this, and now it only pays after the change order has been issued, except for large amounts where it will approve partial payments. Friction sometimes builds with the subcontractor if the owner delays or witholds payments, and this may be a problem area.

The firm does not have difficulty in the control of cost and time associated with change orders except for work done on a time and materials basis where close supervision of the subcontractors is required. In general the responsibility for the control of change order costs belongs to the owners. A problem resulting from change orders as seen by site management is caused by the tardiness of the architect in issuing revised drawings to the site. This holds up portions of work and sometimes causes delays in the whole project. As possible modifications for improving the present system of issuing change orders, the project manger proposes that every contractor submit a complete list of unit prices for items that are in his contract, when he submits a quotation at the beginning of the job. These prices are discussed and are put in the contract; then when an extra cost is incurred only the quality will vary as the unit price is fixed. The project manager adds, however, that this idea does not appeal to the firm nor to the subcontractors because they know there are going to be extra costs on a project and are going to take advantage of the situation. Competition is so severe today that to obtain a project a contractor has to minimize his profits; accordingly he tries to increase his profits on the extras.

4.5.7 Subcontractors

Subcontractors are invited to submit prices by the firm when it is engaged in management or negotiated contracts. However for competitive tenders the firm takes quotes from any subcontractor and will select the one with the lowest price no matter who it is. In the firm the contracts manager is responsible for negotiating and awarding the contracts to each subtrade. He is also the chief estimator who, together with his estimating team, has estimated the project for which the firm submitted a tender and was low bidder. Therefore he is well informed of the requirements of a project; for this reason he has the responsibility for the negotiations and for writing the contracts on behalf of the firm. In the past, each construction manager did the negotiations with the subcontractor himself, but this was discontinued because the firm discovered that this was a lengthy and time consuming process for the project managers who had just been appointed to a project. Besides, at the outset, the contracts manager is in a position to know the project much better than the project manager.

The firm has a policy that requires each trade contractor on the site to complete a daily report (Figure 4.9) stating the number of men he has on site, the number of foremen, and the location and progress of work. This is handed by the subcontractor daily to the clerk who in turn will prepare the daily progress report for the whole project. The project manager receives this information, determines the rate of progress of a project and adopts the necessary measures for improvements when necessary. Furthermore this report is read by the managers of the subtrades at the coordination meetings, where they are asked to state the amount of work which is feasible for their men to do weekly. If a subcontractor falls behind, these reports are used as evidence.

When a subcontractor gets a contract from the firm, he is requested to submit a breakdown of his contract price, especially in cases where quantities are involved. Monthly, the subcontractor is asked for an assessment of his progress which he submits in the same daily report. In this he records the amount of work completed for the month. He also submits monthly a progress claim. Upon receipt of these reports the firm can quickly check the amount of work done from drawings, multiply the quantities by the appropriate price and compare the results to the progress claim to determine whether or not a subcontractor is overbilling, and to approve progress payment. The firm instigated this procedure 5 years ago because in the past, its foreman had to spend as much as 2 hours counting the number of men of the subcontractors every day.

The subcontractor is not compelled to do clerical work for the general contractor. The firm tells its subcontractors that this is a company policy, however, if they do not want to comply, the firm has no recourse. It happens, in fact, that sometimes subcontractors refuse to complete daily reports, but the firm makes them understand that these are required for Unemployment Insurance Commission purposes. All trade contractors on a job, after having completed their work, in order to have the release of their holdback, have to supply the firm with a form from the unemployment insurance commission, stating that they have paid the contribution for the men that were on the job. One other reason for keeping records is in case an accident happens at the site, the records can act as proof to inspectors as to how many men the subcontractors had working on any particular day.

At the site, the firm's superintendent controls the subcontrators and coordinates them in their day to day operations. When the subcontractors are late with their daily progress reports, the superintendent issues reminders.

As mentioned previously, the firm subcontracts 90 percent of the work for major projects. Senior management believes that the firm is not able to handle any more work with its own forces. The firm cannot compete with the subtrades because they are specialists, they do the same work every day and have the best equipment suited for the job. Consequently they can do work for a lower cost than the general contractor. The difficulties encountered by the firm with subcontractors relate to the peculiarities of each individual subcontractor. Much of the problem stems from the unwillingness of some subs to cooperate with the others and to care about the others. This forces the firm's site personnel to persistently remind them about such things as cleaning up after their work. If there is no cooperation, the firm undertakes the work with its own forces and charges the subcontractors for it. Normally the project manager has full authority to deal with subcontractors, and senior management intervenes only when asked to by the project manager. The subcontractor may take advantage of the fact that the project manager is in charge of the subcontractors during construction but the contracts manager has negotiated the contract items. Where the contract does not clearly stipulate whether a subcontractor is responsible for the work, the latter would refuse to do the work. This may cause problems since the project manager is not fully aware of the conditions of the contract; therefore, he must discuss the situation with the contracts manager before making a suitable arrangment with the subcontractor for the completion of the work.

4.5.8 Physical Progress

Since the firm has a computerized cost accounting system, there is a need for company wide uniformity in progress reporting using the applicable cost code. Accordingly, the firm places great emphasis in receiving from the site accurate and timely reports on physical progress of each project. Since the project manager is totally responsible for a project, he is the person who determines the physical progress, approves all claims for payment from subcontractors and suppliers and submits claims for progress payment to the owner. Physical progress of the subcontractors is controlled through the daily reports the latter have to provide to the firm. For work performed by the firm's own forces, the clerk prepares a daily progress report along with daily weekly and monthly cost reports; these are designed to determine the number of work hours associated with each activity. These reports are sent to the project manager and the information on costs is later computerized. Monthly a cost summary is generated by the computer which summarizes the monthly costs for each activity. The project manager compares these costs to the estimate and the daily progress reports from site, and evaluates the actual progress. If actual costs are high as compared with the progress, then he takes the necessary steps to complete the project with the amount of money still available from the estimated total cost of the activity. Every three months the project manager prepares a cost-to-complete report for the vice president of the company, this report gives the overall financial picture of the project. At the site progress is measured by the superintendent through visual inspection. At the end of the day the progress is recorded formally in the daily progress report by the clerk.

On his visits to the site, the project manager inspects the overall progress of the project, and since he is there almost daily he is constantly aware of the state of the job. However he admits that difficulties in the physical progress of a project may arise if the project manager is a little lax, thus allowing the subcontractors to fall behind. Nevertheless, for major projects, company policy is to have coordination meetings with the subcontractors at site. Prior to the meeting, the project manager inspects the site visually with respect to progress, and then he will question the subcontractors as to performance and committment to the following schedule.

Progress reporting by the project manager is informal, although occasionally senior management may search the job files if there are particular issues they are interested in. In general senior management is only interested in being made aware of problems so that they can take action if necessary. According to the project manager, problems in the control of physical progress are caused by subcontractors who refuse to report their progress or submit erroneous reports. This is sometimes the result of the subtrade superintendents who, also working with their tools and being action oriented, find report writing tedious and distasteful. Other impediments to progress are late deliveries of equipment from the manufacturers, which sometimes cause delays in the whole project. When asked for possible modifications to the present control system of physical progress, the project manager, referring to the subcontractors' superintendents, suggested: "If we could make them see that these reports are documents useful not only to us but to them, then it would make progress control easier on the job."

4.6 SUMMARY

Attention has been focused in this case study on the collection, processing, dissemination and retrieval of information for purposes of project planning and control. An attempt is made in Figure 4.10 to summarize the flow of information within the firm for project control. Formal reporting is defined as written information while informal reporting consists of undocumented verbal discussion. Much of the day to day control of a project is executed by way of the latter.

It is clear from the interviews held and the company reports examined that the firm exerts very tight control over its projects. Its main objective of timely completion of projects within budget is reflected in its control practices. Considerable detail is sought in the scheduling and cost breakdown of projects. Control is facilitated by the integration of the processes of estimating, planning and scheduling and control by way of the cost code system adopted. While differences in management style are accommodated, uniformity of reporting is required for all the firm's project managers.

In general, in order to control the project variables, time, cost and content, a contractor manipulates the variables schedule, budget, supervision, labour, equipment, materials and construction methods. When, however, the firm such as the one examined herein subcontracts 90 percent or more of the work, it relinquishes direct control over the last four items listed above. However, the firm studied herein is seemingly able to exert indirect control over these variables (which are directly controlled by the subcontractors) for at least three reasons:

(i) the activities of the subs are scheduled in considerable detail by th general contractor and adherence to the schedule is rigourously enforced;

(ii) subcontractors are required to report in some detail on their activities with respect to supervision, labour, and progress;

(iii) considerable clerical assistance is given to the general contractor's supervisory personnel thus freeing them up for their task of managing time, cost and content.

It would appear that success of the firm can be attributed in large part to:

(i) its detailed scheduling and updating practices

(ii) its uniformity of procedures and reporting

(iii) its use of tools and techniques (i.e. the computer) to free up its management personnel for the task of management

(iv) its division of duties with respect to strategic planning, managerial control and operational control for projects and the recognition of the importance of each of these facets of project planning and control

(v) The support of senior management for progressive modes of working and for formal reporting

(vi) The sense of teamwork that senior management encourages including encouraging the sharing of experiences

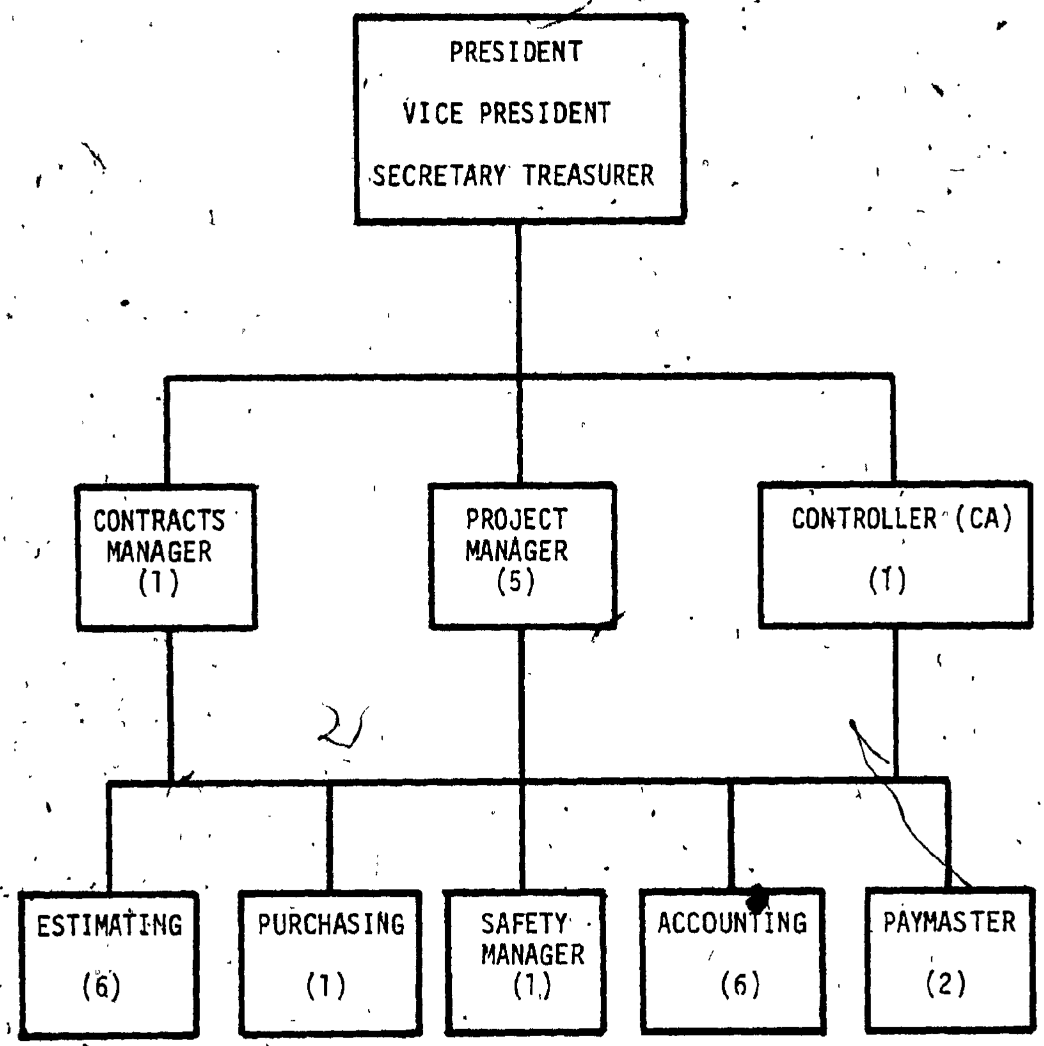
(vii) The use on new jobs of formal feedback with respect to time and cost from previous jobs

(viii) The long association of management personnel one with the other due to low staff turnover.

As mentioned previously, it was difficult to get those interviewed to identity management problems that they are in a position to influence or to identify improvements in planning and control practices that could be made. Two possible areas of improvement, in the author's opinion are:

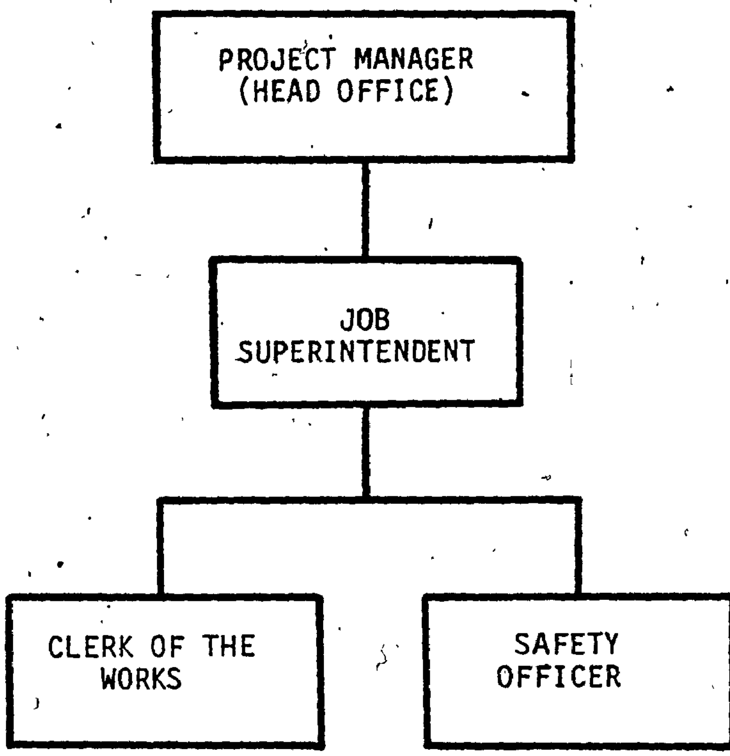
(i) The development of manuals detailing procedures and good practises for the various levels of management personnel including foremen, superintendents and project managers. Such manuals would enhance the present spirit of teamwork, would help in more accurate reporting (e.g. better assignment of cost codes) and would provide benchmarks for effective management of projects.

(ii) development or purchase of additional computer software for use in scheduling, feedback reports to estimating and field reports to superintendents. The use of scheduling software would allow the project manager to explore a greater range of schedules. Manual unit cost reports prepared at present by estimating could readily be computerized, thus freeing estimating staff time.



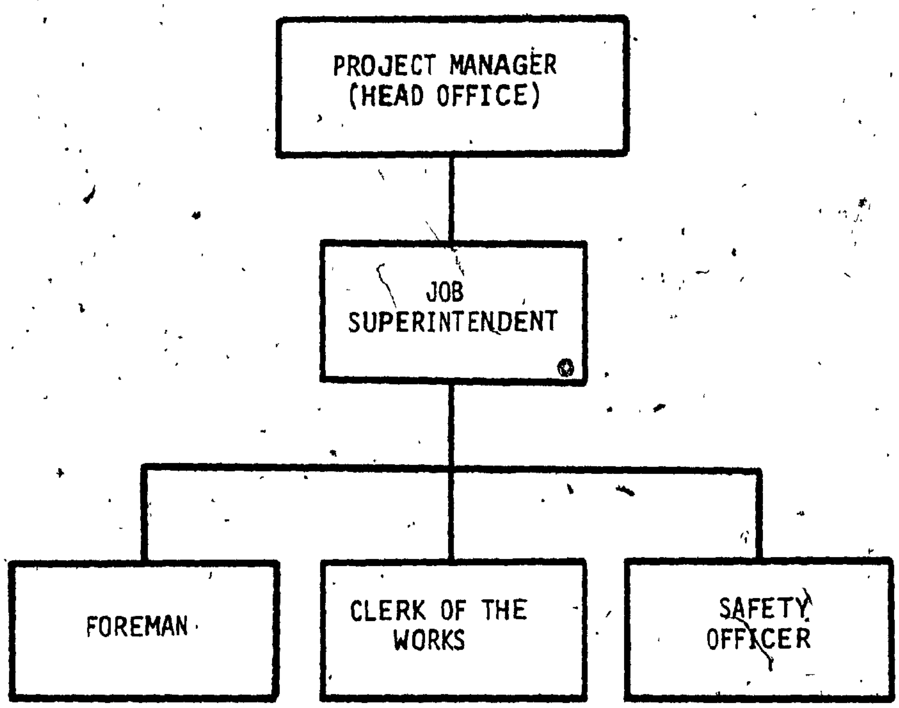
COMPANY ORGANIZATIONAL CHART

FIGURE 4.1



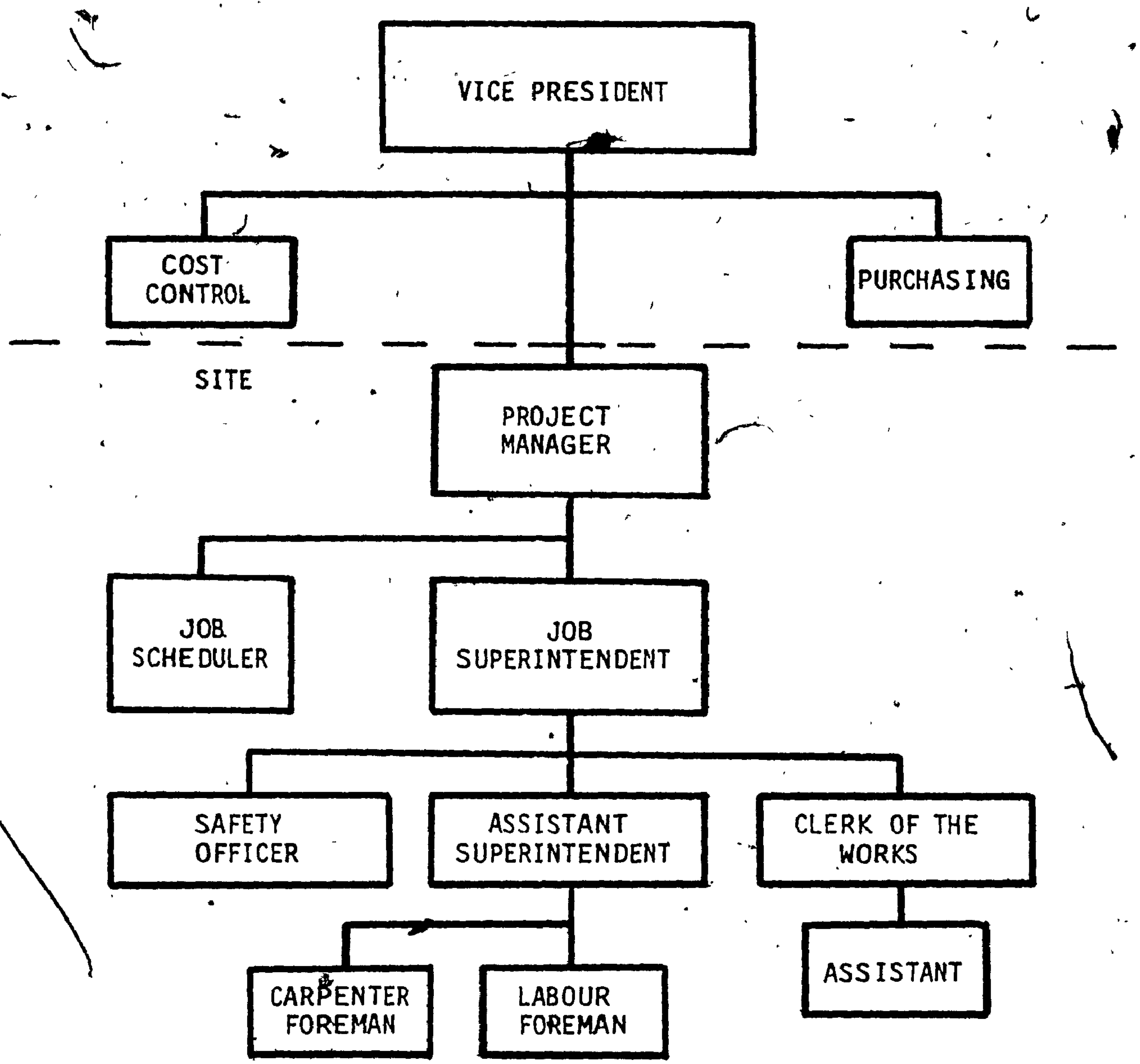
ORGANIZATIONAL CHART FOR PROJECTS OF $200,000 to $5 MILLION

FIGURE 4.2



ORGANIZATIONAL CHART FOR PROJECTS
OF $5 MILLION TO $15 MILLION

FIGURE 4.3



ORGANIZATIONAL CHART FOR PROJECTS OF MORE THAN $15 MILLION

FIGURE 4.4

FOREMAN'S DAILY TIME REPORT

____

____
(JOB NAME)

DATE: ______________________

NAME OR NO.	HOURS WORKED																					RATE	AMOUNTS
	R	O	D	R	O	D	T	O	D	T	O	D	R	O	D	R	O	D	R	O	D		

RATE	CODE →	HR		HR		HR		HR		HR		TOTAL	
												COST DISTRIBUTION	
												CODE NO.	AMOUNTS
TOTAL													

DIST. BY: ____________ FOREMAN: ____________ APPROVED: ____________

FIGURE 4.5

WEEKLY LABOUR COST

PROJECT: ____________________ WEEK ENDING: ____________________

CODE AND DESCRIPTION	THURS.	FRI.	SAT. SUN.	MON.	TUES.	WED.	TOTAL
TOTAL WEEKLY LABOUR COSTS							

PREVIOUS TOTAL: ____________________

TOTAL TO DATE: ____________________ ____________________

Approved

FIGURE 4.6

SUMMARY OF MONTHLY LABOUR COST

SHEET NO: ____________

MONTH OF: ____________

JOB: ____________ SUPERINTENDENT: ____________ PROJECT MANAGER ____________

CODE NO.	DESCRIPTION	COST INCURRED PER WEEK					MONTHLY TOTAL COST	TOTAL PREVIOUS MONTHS	TOTAL COST TO DATE
		WE.	WE.	WE.	WE.	WE.			

FIGURE 4.7

DAILY PROGRESS REPORT

PROJECT: ____________________ DATE: ____________________

TEMPERATURE: MAX. __________ WEATHER: A.M. __________

MIN. __________ P.M. __________

LABOUR				EQUIPMENT	
STAFF	NO.	WORKERS	NO.	DESCRIPTION	NO.
TOTAL		TOTAL		TOTAL	

WORK DONE BY CONTRACTOR

NAME OF SUBCONTRACTOR	NO.	NAME OF SUBCONTRACTOR	NO.

VISITORS

SUPERINTENDENT

FIGURE 4.8

DAILY SUBCONTRACTORS' REPORT

PROJECT: ____________ DATE: ____________

SUBCONTRACTOR: ____________________________

PERSONNEL		EQUIPMENT	
TRADE	NO.	DESCRIPTION	NO.

WORK DONE

SUBCONTRACTOR

SIGNED BY: ____________

CONTRACTOR

SIGNED BY: ____________

FIGURE 4.9

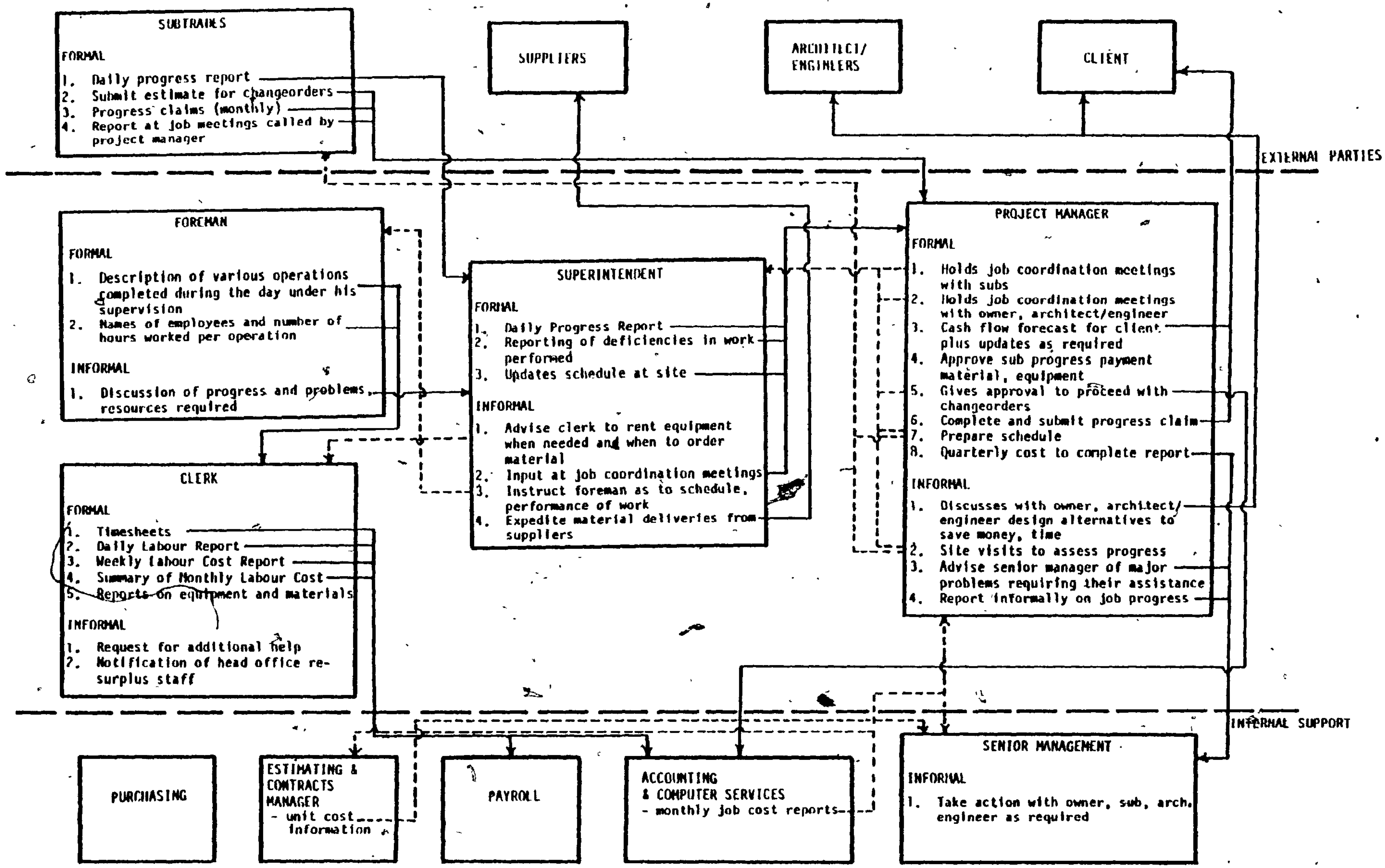


FIGURE 4.10 - INFORMATION FLOW FOR PROJECT CONTROL

CHAPTER 5
CASE STUDY III

5.1 INTRODUCTION

The firm investigated is a successful building contractor based in Montreal. Interviews were conducted with 5 individuals, the president, the vice president, the chief estimator, the project engineer, and one job superintendent. All interviews were arranged through the president, who was present and participated partly in the interviews with the chief estimator and project engineer. The author and his supervisor conducted all interviews which took place both at the firm's head office and construction site. They spanned a period of 5 months. The firm granted permission to record all interviews and offered complete cooperation throughout the process.

Questions were directed at the identification of roles of personnel at various levels and their attitudes with respect to project management. Emphasis was placed on the collection, processing, retrieval and use of information with respect to the management of individual projects. Because the interview process is very time consuming for the firm, there were restrictions on the amount of information which could be obtained. Even though these interviews were not as in-depth as the other two case studies, it was found that a detailed interview such as the one conducted was much more revealing than the questionnaire alone and it became clear that due to the size of the firm, individuals are given a certain amount of flexibility in the way they perform their duties; therefore, it would be more beneficial to interview more individuals in order to get a complete picture of the firm.

The reader must constantly keep in mind that the interpretation of the comments are those of the author and his supervisor alone and they are based on their knowledge of the construction industry. It is also important to note that a slowdown presently exists in the construction industry in Canada; this condition is more acute in the province of Quebec (refer to Chapter 1). Therefore the present situation is not considered normal and this firm, like many other firms is working at a slower pace than it is used to. In consequence its yearly volume of work is decreasing and it is faced with staff cutdowns and the struggle for survival. Accordingly this becomes a time when the firm is searching for possible markets in order to create more stability in the volume of work and profits.

5.2 CHARACTER OF THE COMPANY

5.2.1 Market

The company is a general contracting firm based in Montreal. It began as a developer of large scale single unit housing projects. A subsidiary company was formed to do the contracting; it became successful to the point that presently it is the main source of income, although it is no longer involved in housing.

However, the firm still expressed interest in property management and development, even though presently it is in a state of reflection about the future. This was expressed by the vice president who said: "We are thinking in terms of some reorganization presently and the design of a new prospectus would be among the items we are considering. There is a slowdown in the industry and I think it gives us some time to reflect on where we've gone and where we're going, and perhaps look at some new approaches to the industry". The vice president showed a declining interest in the contracting side of construction. For this reason the firm has done some development work. It has participated in equity positions with some of its clients as well as having undertaken projects of its own in this area. The vice president feels that it is this area in which the firm will become more involved in the future.

Presently the firm operates in the province of Quebec with 95 percent of the work contracted in the Montreal area. Its yearly volume of work is between $10 million and $20 million. In the past this volume has increased steadily at an estimated rate of 10 percent per year with a significant decline taking place since 1976 due to the slowdown in construction in Quebec.

The firm undertakes work by way of lump-sum, negotiated, and management contracts. For negotiated contracts the firm is normally called in with the design consultant to develop a conceptual program for the project and develop a budget. When the design is advanced to the point that the firm is able to price accurately the bulk of the work for the project, it develops a lump-sum or guaranteed maximum cost of the project. Approximately 75 percent of the firm's work in the last 5 years has resulted from negotiated contracts with private developers. For management contracts the firm undertakes either to do construction management where the client would retain or hire his consultants and the firm would work with the consultants and manage the project for a fee, or do the project management where the firm would formulate the whole design team hiring outside consultants and providing its own construction expertise thus giving the client a full package. Presently the firm is involved in contracts which are approximately 50 percent on a fixed-price basis, 45 percent negotiated and 5 percent on a management basis. In the past the firm has had little need to enter into competitive bidding for lump-sum contracts. When it did bid, however, its rate of success was one project for every 20 estimates. The firm is primarily involved in the private commercial sector; 85 percent of its projects are commercial, 10 percent light industrial and 5 percent residential. The firm has in the past also been involved in institutional work, but this has been primarily on an invited tender list. In the past 10 years the firm has not tendered on public projects. This is due to the fact that it has managed to develop sufficient volume and a favourable type of work for selective clients; it has developed a relationship with specific clients, which results in considerable repeat of business.

5.2.2 Objectives of the Firm

The firm's objectives are principally to develop a reputation for timely completion of projects within budget; this tends to create the repeat business referred to previously. A secondary objective of the firm is to generate a minimum predetermined profit from its operations. It is not necessarily a goal of the firm to maximize returns since it tries to develop and maintain a good relationship with its clients. Since the firm is involved in much negotiated work, it believes that the major portion of the profit earning is as a result of the care it takes in planning and the savings achieved which are shared through the contractual arrangements between the firm and the client. Growth is not an objective of the firm. In the past decade the firm was successful in negotiating the volume of work it felt comfortable with. This enabled it to control the volume of work thus keeping within the capabilities of its management people to successfully undertake and perform well.

5.2.3 Organizational Structure

Head office staff consists of 20 people, ~~and~~ includes 5 senior managers (two of whom are retiring), 2 project managers (one of whom is retiring), 1 project engineer, 3 estimators, 3 people working in purchasing and subcontracts, and a clerical staff of 7 people which includes 1 office manager, 1 assistant office manager, 1 payroll clerk, 2 bookkeepers, 1 typist and 1 receptionist. This staff has tended to remain stable over the years, with a small reduction of personnel having taken place recently due to the construction slowdown. There was no indication given by the firm regarding the hiring of new employees to replace the personnel who are retiring. The firm has never formally formulated an organizational chart, however the president drafted one for the author, which is shown in figure 5.1. Of note in the organizational hierarchy of the firm is the fact that usually senior managers also assume the role of project managers. Site staff consists of 6 superintendents and 6 foremen; the firm never employs a clerk-of-the-works.

5.2.4 Projects

At any one time the firm may be involved in 6 to 10 projects which may range in value from $1,000 to $15 million, whose duration ranges from 1 month to 24 months. In the opinion of the vice president, the firm is able to handle a maximum of 4 major projects at any one time; a project whose value is over $1 million is considered major by the firm. The average duration of a major project is one year.

The average value of a project is $7 million with an average duration of one year. Typically 80 percent of the work is subcontracted. The nature of the work done by the firm consists of general labour and carpentry; the firm also purchases materials for some subcontractors. The average work force employed by the firm on a project consists of 12 men, 8 of whom are labourers and 4 are carpenters. The firm does not own any large size equipment, it rents the equipment it needs for the time period required. The only equipment owned by the firm consists of hand tools used by its own workers.

5.2.5 Project Records

Project reporting at the site is done by the superintendent since the firm does not employ a clerk. Even so little emphasis is placed on reports for the purpose of project control, since the project manager and senior management make frequent visits to the site thus becoming aware of the progress through visual inspection. Formal reporting acts only as reference in case of need for disputes.

Job records which are kept at the site are:

- time sheets (see Figure 5.2)
- material delivery record
- equipment rental record
- minutes of progress meetings with subcontractors
- copies of correspondence involving issues at the site
- other records left to the judgement of the superintendent

Job records which are kept at the office consist of the first

5 items above plus a monthly cost report. The firm does not receive a weekly cost report from the site, nor does it make the site aware of costs; it is company policy to keep records of costs away from the site.

5.3 GENERAL MANAGEMENT POLICY AND PRACTICE

5.3.1 Procedure of the Firm

The company has no policy handbook which spells out the roles and responsibilities of personnel, nor any formal training for its personnel. This has not been found necessary since the number of management employees is rather small and the turnover of personnel has been low.

5.3.2 Employee Training

In hiring personnel, emphasis is generally placed on educational background. This has resulted in a staff that has had considerable technical training. Of the 5 senior managers, one is an architect, 3 are engineers and one is a quantity surveyor. One project manager is an engineer, the project engineer has degrees both in architecture and engineering, and the chief estimator is a quantity surveyor. Site management personnel has generally come up through the ranks; from carpenters to foremen to superintendents. The firm has not hired an outside superintendent in the last 10 years. The project engineer was hired as a recent graduate and is being trained to become a project manager.

5.3.3 Managerial Practices

The structure of the firm is informal, and this informality along with an implicit definition of roles, leads to flexibility of the tasks of the firm's personnel. The firm allows its personnel to operate within their limits and only monitors for erroneous behaviour. This flexibility also applies to senior managers who oversee the running of the projects by acting as project managers. In the words of the president: "It has been a policy of this company that the executive officers in the past and presently make it a point of keeping in touch with all jobs". The firm holds monthly meetings with all field management people in which it reviews specific areas of policy and procedure. These sessions usually deal with topics on safety, cost reporting, procedures for controlling the information such as revisions in plans, change orders and the administrative procedures that site personnel could interface with. For each of these sessions a specific manager is given the responsibility under supervision of senior management for the preparation and presentation of the material. In cooperation with the Montreal Construction Association, the firm has arranged a seminar on metric conversion. The firm feels that education benefits its personnel and results in improved performance for the firm. Accordingly it encourages its people to enroll in courses especially in estimating.

5.3.4 Computer Usage

The firm makes use of computers only for payroll; it have no computer of its own. Three years ago the firm hired management consultants to make a study on the feasibility of the firm installing a computer. The results indicated that the firm's volume of work did not warrant the purchase of a computer. In the consultant's view, the firm required an annual volume of three times its present volume to justify acquisition of a computer. The vice president, however, expressed interest in the use of computers, indicating that this is one of the areas the firm wants to investigate in this period of reflection and of slowdown in construction. He says: "We feel today that management skills are pretty hard to hire, and in order to get full utilization of the people you have, and not expand unduly, you need these techniques and these tools that can take a lot of the mundane parts of the operation out and really leave the thinking aspect, the analysis aspect, for the human factor". He continued by saying: "I've given much thought to the use of computers for accounting, for cost control of projects and for schedule control. I think it's a tool that can be significantly in our favour". He believes that computers will generate project information which is fast and reliable and will allow senior mangement to receive feedback on operations. The speed of the computer would also permit senior management to take quick action where needed. The vice president indicated that the firm is limited in the amount of work it can undertake out-of-town because it is difficult for senior management to oversee; the installation of a computer may not require frequent site visits thus allowing more free time for decision-making.

The firm uses a code for all the project activities. This code is similar in nature to the one in Appendix II. Estimating, scheduling and cost keeping is done in accordance with this code; however this is not computerized.

5.4 PERSONNEL

Five individuals provided information on the roles of personnel in the firm; these are the president, the vice president, the chief estimator, the project engineer, and a job superintendent. Descriptions of these roles presented here are the author's interpretation of the discussion held in the interview process. The president was present in the interview with the chief estimator and took part in answering some of the questions directed at the estimator. In defining the various roles, emphasis was placed on project planning and control. Due to the flexibility and informality of the firm, there are some characteristics which deserve mention. The roles of senior management are not clearly defined; one may act in the absence of another. Each senior manager is assigned to a project in the role of project manager;

the firm only has 2 project managers who are not part of senior management, of which one is retiring. Therefore, when referring to a project manager, the author usually implies a senior manager since it is usually one and the same person. In identifying the roles with respect to project management emphasis was placed on the collection, processing, retrieval and use of information. However, some difficulties were encountered because of the informal nature of the information transfer within the firm.

5.4.1 Senior Management

The firm has a nucleus of 5 senior managers. Two are very close to retirement and are gradually relinquishing their responsibilities in the operation of the firm. Ownership of the firm is in the hands of the three remaining managers. The technical training of these individuals includes 1 architect, 3 civil engineers, and 1 quantity surveyor. The senior managers interviewed were the president and the vice president. Very little was discovered from them about their administrative duties, since the president is retiring and the vice president, newly appointed to this position, is consequently still in the learning stage with respect to his new position. Most of the interview was directed towards the role of senior management in project planning and control. It was discovered that in this firm a considerable part of the duties of senior management involves project management.

Therefore under this section the reader will also find the role of the project manager, since in effect the senior manager is also the project manager.

The vice president, a civil engineer, has been associated with the firm since 1960. For the most part his area of involvement has been in the operations end of the firm. In the last few years he has done a great deal of work in the area of negotiations and working as a member of a design-build team. Recently, due to the forthcoming retirement of two senior managers, he has been given added responsibilities in the area of administration and finance.

Since the roles of senior management are flexible, their functions with respect to project management are interchangeable, and the functions applying to one apply to the others. These can be outlined as follows:

- develop together with the architect at the conceptual stage, the initial budget for projects obtained on a negotiated basis
- price the estimate together with the chief estimator
- participate in negotiations with the client for negotiated projects
- after award of the contract, prepare a working estimate; this is more detailed than the initial estimate and includes possible savings by the firm
- instruct the superintendent on the quantities involved and how to proceed with the work

- oversee the development of the preliminary schedule for the duration of a project, and input as to the overhead charges required
- formulate the final schedule of a project, and monitor the work to see that it is in accordance with the schedule
- make frequent site visits, possibly daily to inspect quality, and progress in terms of time and cost
- attend weekly coordination meetings with the subtrades, and meetings with the architect, engineer and owners
- receive and review a weekly labour report from the superintendent
- prepare a monthly cost report related to the progress of the project
- request change orders from the client or his architect and approve change order work to be done by subtrades

Each senior manager oversees a maximum of 2 projects at one time. Because he maintains close contact with the site through frequent site visits, he makes little use of the reports received from the site. Their main function is to serve as a confirmation of what he sees, and, in fact, it was claimed that the recorded information seldom deviates from the observed progress. Monthly each senior manager prepares an analysis of costs and cost to complete for each project. Thus the firm knows roughly on a monthly basis its cash flow, profits and projected profit or loss margins on its projects. In the event that actual costs deviate considerably from estimated costs senior management investigates to determine the cause.

The vice president identified three sources of difficulty in the control of construction projects. The most serious problem is related to the flow of the decision-making process especially with regards to change order work where the architect has to get approval from the client and decisions are slow in being made. This can interfere with the work progress significantly. Another source of problems relates to the owner delaying progress payments to the firm and in turn the firm delaying them to the subtrades. This chain of events can cause friction to develop between the parties involved. A third source of problems is related to the nature of tendering jobs. Due to the usual practice of accepting the lowest bid the firm sometimes has to deal with subcontractors that it does not necessarily prefer. The cooperation of the subcontractor is vital but the firm is not always able to control it; sometimes the superintendent or foreman of the subcontractor is not qualified for the work, leading to possible problems. The vice president also indicated that, especially in negotiated work, the firm has to take into consideration the position of the client who prefers to postpone the finishing work until the space is rented so that custom finishing can be done for the tenant.

In the opinion of the vice president: "The strength of our control procedures is totally dependent on the time available to ourselves to visit the sites and stay close to them. The weakness is that it requires a lot of our time". The firm's projects are located in the Montreal area, which allows senior management to make frequent site visits. However construction locally has slowed down drastically. The vice president indicated that in the future the firm will have to investigate other areas in which case it would become difficult on the part of senior management to make frequent visits to the site. Consequently they must rely on progress reports. The vice president expressed interest in the implementation of computers by the firm in order to speed up the processing of the information contained in the reports so that action may be taken quickly when necessary. He also feels however,that changing the control procedure by using computerized reports requires an education process of the firm's superintendents, putting emphasis on more accurate reporting.

5.4.2 Project Engineer

As mentioned earlier, the firm's senior managers perform the duties of project managers. The firm employs 2 other project managers one of whom is retiring. The firm also employs a project engineer who in the opinion of the president will, with time, assume the responsibilities of a project manager. He is a university graduate with a bachelor of science degree in architecture and a bachelor's degree in civil engineering. He has 5 years experience, the last 4 with the present firm. He is mostly stationed at the site, although at times he is in the office, and acts as a liaison between the site and the office. However, since the firm has only one project engineer, he can only be employed on one project. His presence at the site allows the superintendent to concentrate his efforts on supervision of work and the pushing of workers and subtrades, in order to maintain the schedule. The project engineer at the initial stages of a project will work with surveying instruments in the layout of the building, and as construction continues, he will provide the superintendent with information and solve problems or clarify areas of ambiguity in drawings and specifications, so that the work may proceed smoothly, without delay. The project engineer does not input very much to the schedule made by the project manager. However, he is responsible to make sure that it is adhered to at the site. He corresponds with subtrades, suppliers and consultants by way of memorandums issuing reminders and obtaining the latest information so that operations can proceed smoothly.

5.4.3 Chief Estimator

The estimating department of the firm consists of 3 people, the chief estimator and two assistants. One of them is presently looking after projects in progress. The other, a junior, does calculations, checks, stamps and distributes shop drawings he receives from the architects and engineers. The chief estimator is currently the only one making estimates for new projects. The senior manager in charge of the estimating department is the secretary-treasurer; however due to the informality and flexibility of the firm the chief estimator may report to, and interact with any senior manager. The background of the individuals in the estimating department is one which puts great emphasis on formal education. The chief estimator came from Britain where he graduated from university as a quantity surveyor. He came to Canada one year after completion of his studies; he has worked for general contractors for 22 years, the last 15 with the present firm. One other estimator received a diploma as a technologist and has 9 years experience. The third estimator came to Canada 4 years ago with a degree in commerce. He has attended courses offered by the Montreal Construction Association in blueprint reading and estimating. In the past, the firm had a fourth estimator who had followed courses at a college in conjunction with the Canadian Institute of Quantity Surveyors. He was recently dismissed by the firm due to the shortage of work. In the opinion of the chief estimator, a technical training has little importance to someone becoming a good estimator. He believes that it all depends on the personal ability of the individual.

The duties of the chief estimator are the following:

- starts negotiations of contracts with subcontractors, and hands over the information to the secretary-treasurer for final award
- reviews estimates to see that they are correct and that

every item is included, and ensures that the final price covers every item included in the specifications

- reviews the general conditions portion of the estimate, ensures that the firm is covered on all items, and obtains approval of all necessary bid bonds from senior management
- assigns estimators to perform an estimate.

The chief estimator also performs the duties assigned to other estimators; at present he is the sole person doing estimates. The duties of the estimator include the following:

- prepare a list of subtrades
- pick out from specifications special conditions
- clarify with the architect any item that is not clear on the drawings and specifications and obtains addendums if necessary
- prepare for the preparation of the estimate so that a complete package is submitted for final pricing
- assign cost codes to all items of the estimate
- obtain quotations from all subtrades involved
- make a preliminary schedule in order to arrive at a cost for the general conditions
- once a job is obtained, together with senior management, prepare a working estimate to see where the firm can effect savings

- price change orders when construction is underway for the project
- provide the necessary information to the purchasing department regarding the materials required for a project.

In general, the estimating department does not get involved in the construction phase of a projet, with the exception of the pricing of change orders. Neither does it receive much feedback periodically from projects. The only formal feedback received from the project is the monthly cost report which is made available to the estimators if they wish to refer to it. Informal feedback is obtained from conversations with the superintendent when there is a need. The actual pricing of projects is done by the chief estimator together with the senior manager in charge of the project. According to the president: "Costs are based on past records, previous experience, similar jobs and a great deal of intuition". The chief estimator, when asked if he would prefer more detailed formalized feedback from projects, for the use of estimating new ones, he replied: "That has been through my mind just recently, wondering if it would be worthwhile trying to establish something like this. I have not got past thinking about it yet". On the same topic of feedback from projects, he continued: "If we know too much, we'd be too expensive the next time".

The firm does not have a policy of trying to expose estimators to the construction site so that they can gain a better understanding of the activities involved. The reason given for the lack of such a policy was the limited free time available to the estimators. Whether the firm is estimating a large size project, or a small one the same level of detail is used and the same care is taken. In the event that the firm has many estimates which must be submitted by the same date then estimators must work long hours, and receive help from other individuals in the firm including senior managers in order to meet the deadlines. In the opinion of the president, problems for the estimating department are caused by change orders which, according to him, invariably come at a time when everyone is busy.

5.4.4 The Job Superintendent

A job superintendent is assigned to each project and is responsible for the running of the job site. He is stationed at the site where he supervises the men, coordinates the trades, approves the quality of the work and handles the day to day problems. The superintendent interviewed normally handles projects whose average value is $7 million and whose average duration is one year. On such a project, assisting him would be 4 carpenters, 8 labourers, and a foreman who is chosen from this group only at peak periods. He started to work in construction in 1950 as a carpenter after obtaining a diploma as a technician. Two years later he transferred to the present firm where, with time, he became carpenter leader, foreman, and finally superintendent. His main functions may be outlined as follows:

- schedule activities at the site, projecting them sometimes up to one month in advance
- layout the building in the initial stages of construction
- order the materials needed for work done by the firm's own force, through the purchasing department
- procure rented equipment when required and return it when no longer needed
- instruct subtrades as to the dates they are to start on a project
- coordinate subtrades, instruct them on mode of operations, measure their progress and count their men on a daily basis
- control quality of work and see that it is done according to plans and specifications
- supervise carpenters and labourers directly employed by the firm
- complete daily time sheets and assign cost codes to the hours of each man
- send to head office weekly time sheets which consist of the daily time sheets assembled together for each week
- assign code numbers to slips for material received at the site, in accordance to the activity which the material is used for
- issue minor changes, and inform the subcontractor to execute the work

- maintain a daily record of rented equipment and assign a cost code as to where equipment is used
- take part in meetings with the architect and the client, and in coordination meetings with subcontractors
- record in a journal daily events, progress and major problems encountered; these act as documents in case of need for future reference

During the day the superintendent walks around the site and remarks on the work done by all the firm's men. At the end of the day he takes approximately 15 minutes to record the information. He claims that by doing it daily he is able to remember exactly the work done. However, if he misses one day he loses the rhythm and tends to forget what was done when. He estimates that he spends approximately 2 hours daily mostly after the working hours on correspondence, recording progress, and contacting by telephone superintendents of subtrades and suppliers to try to solve issues so that the project progresses without delay. In fact the superintendent keeps various records in the form of memos. The only formal progress reporting he does is to complete time sheets which he sends weekly to the office. The only feedback he receives from the office is in the case of mistakes. The firm does not require from the superintendent daily or weekly progress reports.

The superintendent believes that coordination is the key to a successful project. He views the maintenance of a project on schedule and finishing on time as his first priority. In his opinion the factors that create problems and the schedule to deviate from that planned are usually caused by subcontractors being late in executing their work, and suppliers being late in the deliveries of materials, although he pointed out that these factors may vary depending on the project. The superintendent also believes that the firm's strengths lie in the quality of work produced by the firm.

5.5 SPECIFIC MANAGEMENT PRACTICES OF THE FIRM

Part of the intent of the questionnaires was to obtain a more in-depth grasp of the control phase of construction projects. Project control implies control of time, cost and content. These variables, however, can be controlled only indirectly since they are dependent on other variables. For building construction these are: cost keeping, scheduling, labour, materials, equipment, construction methods, change orders, subcontractors and physical progress. With regards to these variables, interest lies with the information flow the company uses for control, the processing of this information, feedback obtained, actions taken, and major problems which tend to hinder control. Initially, the author started with the premise that control could be described by way of a systems analysis model which is based on information flow; this premise is reflected in the questionnaires. However, it turned out that the personnel of the firm do not think in terms of such a model. This is consistent with the fact that the firm does not have a procedures manual nor detailed written job descriptions. Consequently, the interviews proved to be very useful since their focus was redirected to comply with the procedures used by the firm.

The questionnaires had been structured to cover general aspects of control as well as specific technical details. However the systems implemented by the firm are basically rudimentary in nature. Thus by answering the general questions the specific ones were also answered. There is little mystery to the process. The firm operates mostly informally, and has little sophistication and complexity. Seemingly the firm has very few problems. Employees did not want to criticize the firm's practices. Therefore it became very difficult to determine if there were any problems with procedures. Problems with the industry, were better identified; however these cannot be resolved at the project management level.

5.5.1 Scheduling

At tender time the firm prepares a preliminary schedule in order to estimate indirect costs and to estimate the extra cost of construction during winter. It is usually prepared by the estimator in consultation with senior management and the subcontracts department. Upon the award of the contract or at the commencement of construction this schedule is revised, refined and detailed, in order to produce the final schedule. The final schedule is usually in bar chart form which consists of approximately 50 activities. The president says: "One of the things we have stayed away from, is becoming slaves to a computer on a critical path schedule". The breakdown of the schedule is divided into activities which reflect the cost codes, used in the estimate. The schedule, however, is less detailed than the estimate in that several items in the estimate are aggregated into one activity in the schedule. Major activities such as concreting, are subdivided into detailed components having time units consisting of days rather than weeks or months. Usually the firm develops a rough schedule consisting of the work which it feels can be done by subcontractors, gets the latter's approval concerning the ability to meet the deadlines, and then finalizes it.

The firm monitors the schedule very closely by frequent site visits by senior management. The coordination meetings with the subtrades are also used as a means of pushing the subcontractors to meet the deadlines to which they agreed. The actual updating of the schedule is done by the project manager only when there are significant deviations or there are significant changes to be made to the work originally stipulated. At the site, the superintendent's major concern is to have the work executed according to schedule. In the opinion of the superintendent, the most important requirement to keeping the project on schedule is the proper coordination of the subtrades.

5.5.2 Cost Keeping

Senior management is responsible for project cost accounting.

The working estimate which is formulated after the firm has acquired a project is used for comparison with actual costs. It is also used in a modified form for the firm's progress billing. The only other formal project cost report generated in the office is the monthly cost summary. The information for this report is obtained from the reports received from the site and from visits to the site by the senior manager in charge of the project. The superintendent is given a booklet with all the cost codes of activities, and daily when he records the hours worked by the men in the time sheets (Figure 5.2) he allocates them to the proper cost code. In the office, the paymaster allocates the costs. Material and rented equipment received at the site is also allocated to the proper cost codes. Monthly subcontractors also submit a bill for progress payment from the firm. The monthly cost summary is circulated to all senior managers and is made available to the estimating department in case of need. The project cost processing is done manually; the vice president feels that it is slightly outdated in terms of the time required and the amount of feedback that senior management receives. He says: "We can't rely on grinding out once a month all the costing because it is too late to take effective corrective measures, so our reliance is presently on our site visits and watching physically the operations being performed and making sure that it is efficient and effective within the cost estimate we projected. So this takes a significant amount of management time". By keeping close contact with the site, senior managers are well aware of all activities. Consequently when preparing progress billings for the clients, they know roughly the percentage of work that has been done. When they are uncertain they call the superintendent who provides the necessary information based on visual observation.

The vice president feels that the project cost reporting does not reflect accurately the actual site progress; he believes that the total expenditure is correct, but the breakdown is not. He says: "We would have to analyze carefully the costing to develop cost units for future jobs because they are not accurate in themselves". In the opinion of the vice president, the more accurate the reporting the firm receives from the field, the less time is required by senior management for site visits, and the more time that can be used for creative work.

5.5.3 Labour

As previously mentioned, the firm executes 20 percent of the work with its own forces. The nature of this work is general labour and general carpentry. At the site, labour is controlled by the superintendent. He inspects all operations daily, and visually assesses the rate of productivity. At the end of each day the superintendent takes 15 minutes to record on daily time sheets the number of hours each man spent on each item of work. The superintendent is required to maintain these records. The time sheets are sent weekly to head office. There is no feedback received from the office, except in the case of a serious error. The firm, however, has no formal way of controlling productivity. Normally the superintendent knows his men very well since most workers have been with the firm for many years, thus he knows how to handle each one of them. The firm does not have a foreman on projects except for peak periods, and even then his concern would be to push the men, as opposed to writing reports. The superintendent feels that he must be the one to do the reporting or else he loses control.

The superintendent directs the men as to the work he wants done and how to do it. Sometimes he discusses with his men how to tackle parts of a job so as to facilitate the work and minimize costs. As mentioned previously, the firm's labour force has been employed by the firm for a long time. They have been selected over the years and are transferred from one project to another. In fact when the superintendent needs a new man he goes through head office to see if a man is available from another project. Only if there is none available would the firm hire outside help. This allows the firm to maintain a steady and dependable work force.

In the opinion of the superintendent, the firm has no major problems with controlling labour. He says that this is due to the fact that the firm has a steady work force. He adds that the only difficulties that arise are related to the hiring of new men. He says that new employees have to be supervised carefully all the time, and if their performance is not satisfactory, the firm will not keep them.

5.5.4 Materials

The firm purchases all materials for work done by its own forces and some material for work done by subcontractors. Initially the material required is estimated and assigned cost codes by the estimating department, and the quantities are given to the project manager, superintendent, and the purchasing department. The latter handles the purchasing of all materials. At the outset of a project, suppliers are asked to provide the firm with a delivery schedule for equipment to be manufactured for the job. These dates are thus incorporated in the main schedule. The superintendent, who does the expediting, contacts the suppliers periodically to ascertain if a material delivery will be late. If so, he attempts to coordinate the work, in order to minimize delays. When materials arrive at site, the superintendents assign cost codes. Since he is usually the only management employee at site, the control of materials is delegated to him. Formally he fills out a material allocation report. Informal control is done by visual observation. Problems related to materials are usually caused by late deliveries which can result in significant delays in the project schedule.

5.5.5 Equipment

Most of the equipment used by the firm is rented as the need arises. The only equipment owned by the firm consists of hand tools which are used by its own labour force. The superintendent requests the equipment as it is needed, and the purchasing department makes the arrangements for the rentals. To control the use of equipment, a record is kept of equipment on site. The superintendent records the days that the equipment is in use and assigns the appropriate cost code against the equipment usage. Consequently the rental fee is charged to the specific activity. Informal control of equipment is done by the superintendent and by senior management on their site visits. This consists of visual inspections taking place to determine the usage made of equipment. The only problem cited with control of equipment is that sometimes there is a tendency to keep it at site longer than needed.

5.5.6 Change orders

Instructions for change order work are normally given by the architect, engineer or client during discussions at progress meetings with the firm. Very seldom are special meetings called to discuss the issuing of change orders. The project manager normally receives estimates from the estimating department and from subcontractors and compiles the information; upon receipt of approval by the architect, the firm proceeds with the work. The firm issues cost codes for all change order work; this is kept separate from the other items of work. The project manager issues change orders to subcontractors. On the average project, there are approximately 60 major change orders although in some cases this number may reach 100. Along with these there are changes made which are related to tenant requirements; these usually are of minor importance.

The superintendent feels that change orders are not the cause of major problems at the site although the president views them as creating problems in the office. Inevitably they come at times when the firm is busy submitting new estimates and consequently they become obstacles. Change orders imply considerable paperwork. Sometimes senior management must constantly pursue the client to authorize the work and expedite the payments.

5.5.7 Subcontractors

As mentioned earlier, the firm subcontracts approximately 80 percent of the work. Negotiations with subcontractors are initiated by the chief estimator, and are finalized by the senior manager in charge of subcontracts. At the outset of a project, the firm discusses with subcontractors starting dates and durations of the latter's work. Of importance to the firm is that the subcontractors maintain their schedule and that their workmanship meet the standards set by the firm. At the site, the superintendent coordinates the work of the subtrades and determines whether the quality is satisfactory. The superintendent interviewed believes that coordination is the key to success at the site level; this implies having very good control of the subs and scheduling them so that no time is lost. Every day he takes a physical count of the men of the subtrades and he records the information. He also records the rate of their progress and makes sure that no delays are caused. When there are major issues such as delays to be resolved, it is done by the project manager at the weekly coordination meetings. Here the actual progress of subcontractors is measured against their estimated one and measures are taken if necessary. In the case when a subcontractor refuses to cooperate, the only recourse the firm has is either to execute the work with its own forces and backcharge the subcontractor for the costs incurred, or to replace the subcontractor. According to the superintendent normally the problems encountered with subcontractors are not major. Usually subs require pushing in order to do the work on time and according to plans and specifications. He added that the firm is normally able to hire good subs, and sometimes the blame for poor performance lies on the foreman of the subcontractors, since some foremen do not have the proper qualifications. According to the vice president the firm sometimes has no choice of whom to choose; this coupled to the lack of adequate personnel and unwillingness to cooperate can sometimes lead to major problems of control.

5.5.8 Physical Progress

The senior manager responsible for the project is also responsible for its physical progress. He approves all claims for payment from subcontractors and suppliers, and submits claims for payment to the client. He monitors physical progress during his site visits by physically watching the operations being performed and ensuring that work proceeds efficiently and within cost estimates. The job superintendent also monitors and measures physical progress. This is done by means of constantly supervising and coordinating the work on a daily basis and by estimating visually the approximate progress. There is no formal reporting by site personnel on physical progress. The firm therefore relies heavily on the information gathered from the site visits of the senior manager. Generally the senior manager knows the percentage of work done; if he is not certain, he calls the superintendent for further clarification. Normally the physical progress of the subcontractors is assessed firstly by the superintendent by reviewing their progress claim, and then by the senior manager for final approval and payment.

The vice president admits that the measurement and reporting of physical progress is not accurate. He says: "We realize that the superintendent has enough responsibility that we do not want to overburden him with detailed breakdowns and reporting. We are more interested in the flow of the progress of the work". He also says that since the firm's labour input is small, there is no need for emphasis on accurate reporting. He continues that in his opinion, if the firm made use of a computer the firm would implement better reporting, get better feedback and the necessary action may be taken more readily.

5.6 SUMMARY

Attention has been focused in this case study on the collection processing, dissemination and retrieval of information for purposes of project planning and control. An attempt is made in Figure 5.3 to summarize the flow of information within the firm for project control. Formal reporting is defined as written information while informal reporting consists of undocumented verbal discussion. Much of the day to day control of a project is executed by way of informal reporting. Formal reports prepared by the firm for project control were not shown to the author. Control was not shown to the author. In particular, the level of detail in the estimate, schedule and monthly cost report was not examined. The degree of integration of these reports could not be ascertained.

The main objective of the firm, that of timely completion of projects within budget is not backed by way of extensive formal estimating, planning, control and feedback. It is seemingly pursued through the hiring of technically qualified personnel, close day to day project supervision by senior management and extensive experience of the firm's personnel. Reporting is largely exectutes by informal means. The degree of uniformity of reporting by project management and site management personnel could not be ascertained although the individual interviewed indicated that different management styles and mode of work are accomodated.

It would appear that success of the firm can be attributed to the following reasons:

(i) Most of the firm's work is negotiated and consists of repeat business.

(ii) Management is careful to take on only that amount of work that it can execute comfortably with existing personnel.

(iii) Management staff are highly qualified technically, have considerable construction experience and have worked together for a long time. The importance of the high technical qualifications of the firm's personnel with respect to its success could not be ascertained. It is of interest to note, however, that the level of sophistication of the firm's procedures is similar to firms whose personnel do not possess degrees in architecture or engineering.

(iv) All the firm's work is conducted in the same market region and it is intimately familiar with the suppliers and subs in this region.

(v) Senior management is directly involved in both the managerial and operational control of individual projects and keep informed by way of frequent oral reports, site visits and by direct preparation of monthly cost reports.

As mentioned previously, it was difficult to get those interviewed to identify management problems that they are in a position to influence or to identify improvements in planning and control practices that could be made. In fact, due to the impending retirements of several key senior personnel, the firm is currently examining these issues and is attempting to undertake strategic planning with respect to its future. Suggestions for possible improvements based on the information obtained are:

(i) Documentation of roles and responsibilities of personnel and procedures to be followed.

(ii) Development of a manual or computerized job cost accounting system which permits the routine aspects of report preparation to be delegated to a clerk or machine, thus freeing project management time. This system should provide reports on cost and time to complete to facilitate prompt action on problem areas and feedback reports to estimating staff.

(iii) Development of a subcontractor reporting system on which the subcontractor is required to completed daily reports on number of men on site and progress made.

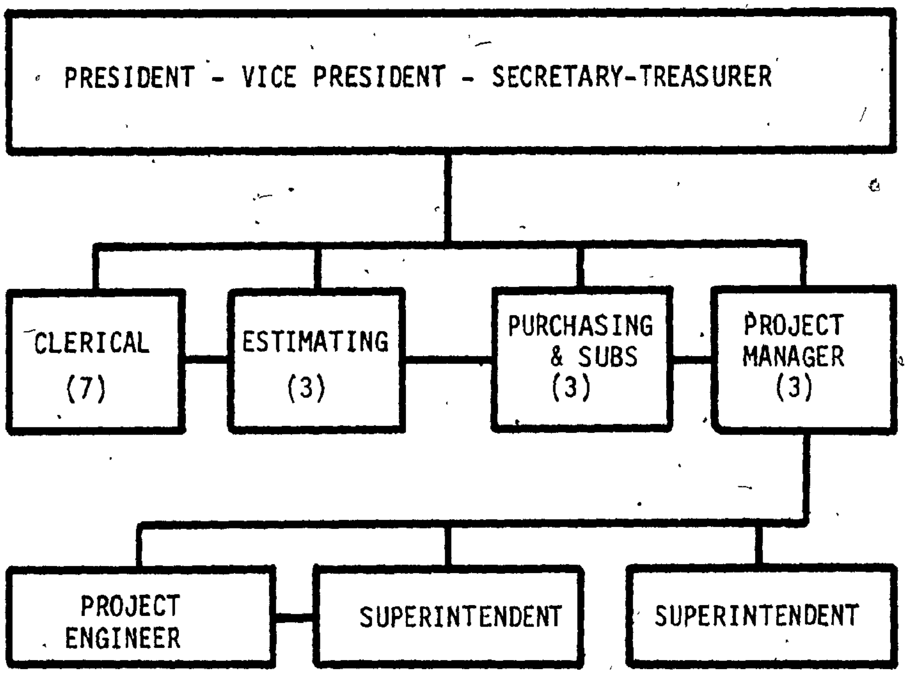
Potential benefits from such improvements would include:

(i) More time available for senior management to undertake strategic planning and management control.

(ii) More time for site personnel for operational control.

(iii) The provision of more timely reports for effective project control.

(iv) The provision of important feedback to management on project performance in terms of time and cost for use on future projects.



COMPANY ORGANIZATIONAL CHART

FIGURE 5.1

DAILY TIME SHEET

JOB STAFF

Superintendent	______	JOB #	______
Engineering	______	PROJECT	______
Clerical	______	DAY & DATE	______
General Foreman	______	PREPARED BY	______

CODE / DESCRIPTION — EMPLOYEES / NAME						TOTAL HOURS	REMARKS
TOTAL HOURS							

ADDITIONAL REMARKS

FIGURE 5.2

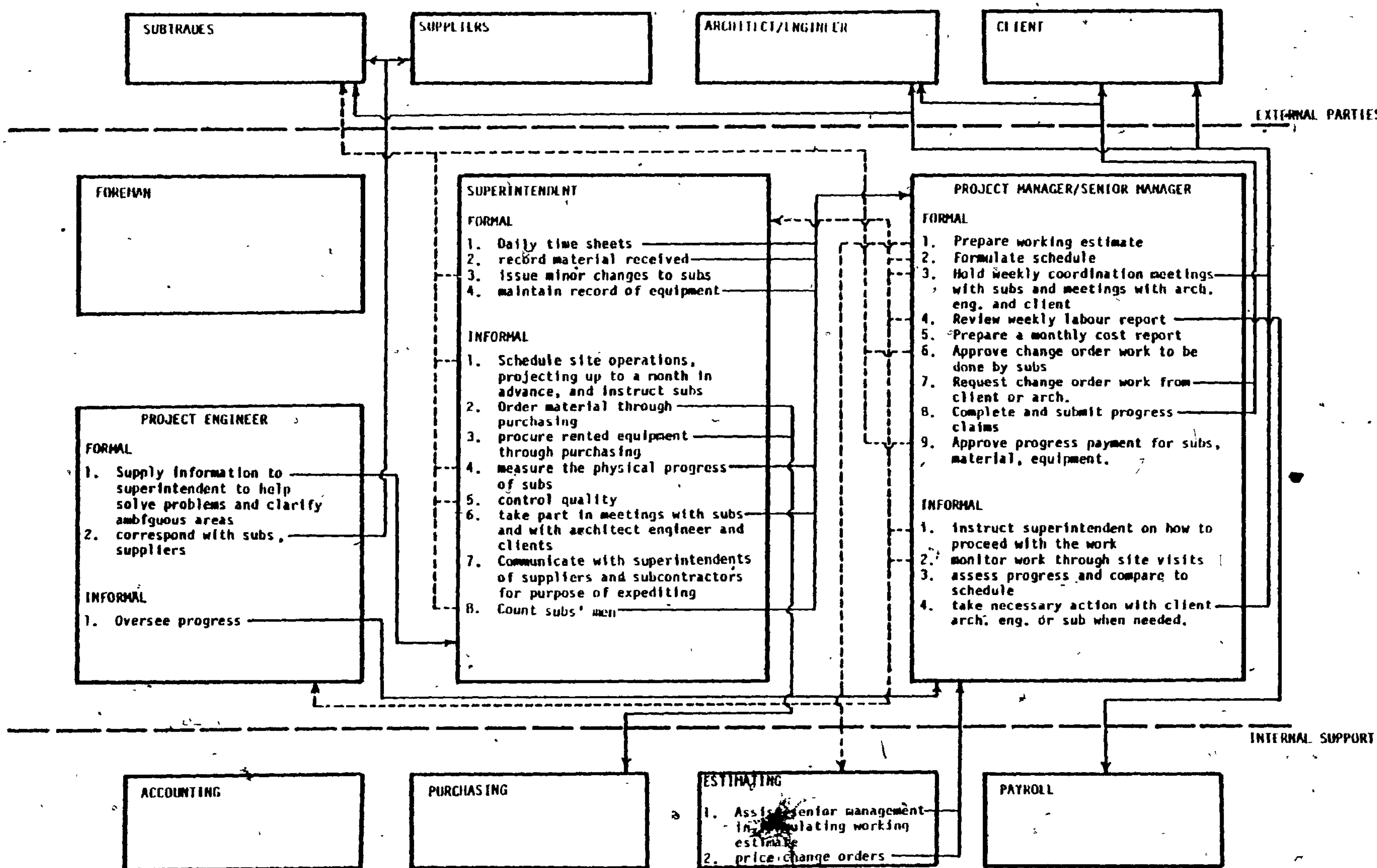


FIGURE 5.3 - INFORMATION FLOW FOR PROJECT CONTROL

CHAPTER 6

6.1 CONCLUSIONS

This study provides a description of the building contractor with respect to the problem of project planning and control with emphasis on the latter. Detailed case studies of three successful Montreal-based general contracting firms engaged in building construction, are presented in which characteristics of their oganization are explored. Also provided is a framework for research on the design and development of contractor MIS in which key MIS variables and parameters describing each variable are identified. Where possible, the implications of these parameters with respect to the design of MIS for individual project control are noted. The cooperation of the contractors interviewed was fundamental in this study, and their openness in providing information has allowed the objectives of this study to be met.

6.2 OBSERVATIONS

The main characteristics of the three firms in the case studies with respect to the framework put forth in Chapter 2 are outlined in Tables 6.1, 6.2 and 6.3. Observations which can be made about the three case studies with respect to the same framework are outlined below.

6.2.1 Problem

The firms subcontract 70 to 95 percent of the work. This implies that emphasis is transferred from planning and control of manpower and equipment to that of control of subtrades. This control can only be exerted indirectly through the schedule and coordination function of the general contractor.

2. The size of the projects combined with the fact that a large quantity of the work is subcontracted does not permit the firms to keep a large site staff which can maintain detailed records.

3. Since the firms rely on repeat business from the same clients, their projects are usually similar in nature. This allows the firms to depend on past experience thus partially justifying the lack of need for formal reporting. However, by keeping few formal records, the firms are limited in the opportunities of obtaining work which is technically more complex and requires the maintenance of accurate records and formal reporting.

6.2.2 Organizational Context

(i) Of the three firms examined, two are family owned. Their organizational structure and communication mode are very much influenced by this type of ownership. The owners generally seek to have extensive knowledge of day to day operations and limit quite carefully the extent of delegation of responsibilities to non-family members and/or senior management personnel. This manner of operating appears to leave little time for reflection on key decisions and for long range planning. The extent of delegation of responsibilities and degree of long range planning by senior management appears to increase with firm size.

(ii) The objectives which govern senior mangement's decision making for all three firms, in order of importance, are survival, development of a reputation for timely completion of projects within budget and a specified percentage of return on volume. Except for one firm, no formal strategy aimed at achieving these objectives was identified. Growth was not an objective of the firms, indicating a general satisfaction with their present size and market.

(iii) The firms studied are marked by a high level of stability with respect to key field and office personnel. Employees within the firm have tended to grow old together. Their close association over the years has obviated the need for formalized information and communication systems. This has resulted in a minimum of bureaucracy, but on the other hand has tended to limit the growth of the firm.

(iv) Heavy emphasis is given to on-the-job training and previous experience. This induces in the firms a tendency to maintain the status quo with respect to their mode of operation. Consequently, it is very difficult for new employees possessing knowledge of more progressive modes of working to effect change within the firm.

(v) In terms of organizational theory, the organizational context is best described by a combination of the classical approach and human relations approach. Little evidence was seen of a systems approach to management - i.e. emphasis being placed on information-flow. Since most designs of information systems reflect the systems approach, especially those which are computer based, care must be taken to have an MIS designed for a contractor reflect the way in which the firm operates. It is unrealistic to expect large changes in the mode of operation of a firm.

6.2.3 Person and Psychological Type

(i) Most of the personnel within the firms examined had high school education and many years of on-the-job training and experience. The number of professionals employed by a firm seems to be correlated with the educational background of senior management. Even when engineers are employed, they too act on experience gained from the jobs rather than using their technical know-how to innovate management procedures.

(ii) Most of the personnel interviewed analyze problems through "intuition" and "feeling". They use few quantitative methods.

(iii) Firms seldom seek outside help. Management personnel move up through the ranks of the firm. Skills sought by senior management are usually similar to its own; this creates the same "psychological type" throughout the firm.

(iv) Communication skills of management personnel are affected by their experience and education. Since the majority have difficulty communicating formally, a low level of confidence is placed in the accuracy of written reports; oral communication is preferred.

6.2.4 Evidence and Mode of Presentation

(i) Only one firm, the largest, makes use of computers in project planning and control. No firm uses network techniques on a regular basis, nor is senior mangement supportive of their use. At best, detailed bar charts are developed for large projects. Only one firm updated the bar chart on a regular basis. At site level no one is able to work with CPM. In general, lack of motivation exists in investigating the use of the computer as a tool.

(ii) The degree of formality and frequency of reporting and communication increased with size of firm. Feedback from completed jobs for use on future ones is extremely limited and is done more by oral than written means. Thus experience is seldom documented in a form which can be readily communicated to others or referenced by others.

(iii) The job cost accounting system for the firms examined ranged from almost no system to a highly detailed computerized one. It would appear that a firm which lacks such a system is precluded from potential opportunities such as large institutional projects and construction management contracts for which detailed cost records must be maintained for the client.

(iv) Cash flows are usually generated at the request of the of the client for use of the client not for project control by the firms.

6.3 AREAS OF POSSIBLE IMPROVEMENTS

Based on the findings of the case studies which relate to the organization of the firms, possible improvements are suggested:

1. Documentation of roles and responsibilties of personnel and procedures to be followed.

2. In-house seminars to promote the need of accurate reporting so as to achieve confidence in the reports made.

3. Development of a subcontractor reporting system to assist in providing formal control over subcontractor progress.

4. Development of a manual or computerized job cost accounting

system which permits the routine aspects of report preparation to be delegated to a clerk or machine, thus freeing up management time.

5. Development of a forecasting system to project cost and time to complete to facilitate prompt action on problem areas and provide estimating staff with feedback reports on costs for use on estimating future projects.

6.4 RECOMMENDATIONS

Based on the findings of the present study, the following recommendations are offered for further research work on management information systems for the building contractor.

1. To identify the nature and diversity of values in the variables PROBLEM, ORGANIZATIONAL CONTEXT, PERSON AND PSYCHOLOGICAL TYPE, and EVIDENCE AND MODE OF PRESENTATION based on the findings in the case studies and to explore their implications for MIS design.

2. To continue the interview process with contractors. This involves increasing both the number of firms and management personnel interviewed, as well as making amendments to the questionnaires if necessary, in order to reflect more closely the nature of each building contractor's operations.

3. To create awareness on the part of the contractors of existing techniques in the area of project management; point out the

strengths and weaknesses of these systems and the feasibility of their implementation by the building contractor. This may be done by way of a short course.

4. To initiate work on the design and development of project management information system for the building contractor which is basic in nature, and simple to understand and use. It should not require drastic changes in the personnel a firm has nor in the way the firm operates.

TABLE 6.1

CASE STUDY I

I. ORGANIZATIONAL CONTEXT

A. Firm

- Non-residential building contractor based in Montreal;
- In business for over 30 years;
- Family owned;
- Specializes in shopping centres and has built 50 in the last 10 years.

B. Objectives

- Objectives of firm are: 1) survival
  2) development of a reputation for timely completion within budget
- Growth is not an objective
- No specific strategy cited for obtaining objectives.

C. Project Staff

- 3 senior executives
- 5 project managers
- 3 estimators (job captains)
- 7 superintendents
- 7 foremen
- Project staff for large projects consists of the vice president, a project manager, a job captain, one superintendent and at least one foreman.

D. Work

- yearly volume $10 million to $20 million, increased at a rate of 10% per year until 1976 when it declined due to Quebec situation.
- Totally in the province of Quebec with 80% in the Montreal area.
- Contracts are 40% fixed price, 40% negotiated, 20% management

- Large portion of work is obtained from repeat business.
- When the firm enters into competitive bidding its success rate is 1 job in 16 bids.

E. Classification of Decision Types Made by Project Staff for Project Control

Parameters	Senior Management	Project Manager	Job Captain	Job Superintendent	Foreman
Strategic Planning	YES	NO	NO	NO	NO
Management Control	YES	YES	SOME	SOME	NO
Operational Control	SOME	YES	YES	YES	YES

F. Definition of Responsibilities and Policies

- Communication does not follow direct lines of command, rather it takes shortest path
- no written job desciptions except those made up by one project manager and not adhered to by firm
- no policy manual outlining procedures to be followed exists

II PROBLEM (Project Planning and Control)

A. Characteristics of Average Project

- Value: $10 million
- Duration: 12 months
- Form: 1 storey shopping centres
- Technical complexity: simple (standard features)
- Degree of definition: at times only conceptually defined at the outset
- Familiarity to firm: repetitive nature of projects leads to high familiarity of project staff with project type
- Contractual arrangement: negotiated
- Percentage subcontracted: 70 percent
- Total work force at peak: 150 men
- Firm's work force at peak: 50 men

B. Environment

- Client: Private investors
- Construction Mode: Fast Tracking
- Labour types provided by firm: masons, carpenters and labourers
- Material provided by firm: usually supplies for work done by own forces
- Suppliers: mostly local
- Equipment: firm owns no heavy equipment. When need arises equipment is rented; subcontractors provide their own eqiupment
- Subcontractors: mostly local
- Extras: average of 300 change orders, value is 20% of total value of projects

C. Control System

i Techniques:

- simple bar chart consisting of 30 activities; not followed beyond halfway point of project
- no cost code system
- no formal cost accounting
- no use of CPM

ii Information System:

- few formal records kept and utilized. No uniformity in recording practice between project managers. System is manual and largely verbal or informal..
- at site job records are kept by superintendent; the firm employs a job clerk only for very large projects.
- no job cost records are kept at site.

iii Control Variables:

- schedule
- supervision
- visual inspection
- experience with similar jobs
- regular job site meetings

iv Management Action:

- monitor and measure progress by way of visual inspection
- pursue subs; insist on good quality work and qualified site personnel
- overtime

III PERSON AND PSYCHOLOGICAL TYPE
with reference to Project Planning and Control

Attributes	Senior Management	Project Manager	Superintendent	Job Captain (estimator)
Age	All over 50	from 40 to 65	all over 40	25 to 65
Education	2 High school 1 engineer	High school 1 quantity surveyor	High school at most	1 uncompleted university, 1 unrelated university degree
Experience	on the job experience	work their way up	work way up through the ranks	work way up through ranks
Technical Skills	no formal technical training	mostly former carpenters only 1 quantity surveyor	mostly former carpenters courses in blueprint reading and estimating	1 has taken courses in civil engineering; 1, evening courses in blueprint reading and estimating
Communication Skills	mainly verbal	mainly verbal	verbal	verbal and formal
Management Skills	no formal management training	No formal training	No formal training	No formal training
Responsibility	oversee and partake in the day to running of the projects	Dependant on experience of individual	day to day running of job	only for quantities
Openness to New Ideas	Satisfied with status quo	Satisfied with status quo	Satisfied with status quo	Satisfied with status quo
Preferred Mode of Evaluation of Problems	judgement based on past experience	judgement based on past experience	judgement based on past experience	judgement based on available data.
Preferred Mode of Perception of Problems	Intuition based on past experience	Intuition based on past experience	Intuition based on past experience	Intuition based on past experience

IV EVIDENCE AND MODE OF PRESENTATION

A. Information Gathered:

- man hours, material deliveries, equipment hours, job progress, sub progress, change order work.

B. Method of Generating Information:

- mostly informal, visual inspection preferred
- very little processing is done for purpose of project control
- for progress payments quantities are measured
- time sheets for labour but time not charged against activities

C. Mode of presentation:

- Informal: oral reporting from site
  minutes of job site meetings
- Formal: Tabular reports of project progress for clients

D. Frequency of reporting:

- normally weekly for job meetings
- oral reporting is done at irregular intervals

V APPARENT PROBLEMS WITH PLANNING AND CONTROL

- Control over subcontractors' performance
- Change order work disrupts planned schedule
- Lack of confidence by senior management in written reports

VI APPARENT STRENGTHS OF THE FIRM

- Reputation fo bringing projects in on schedule within budget
- Personnel highly experienced and have worked together for many years
- Able to fast-track successfully
- Flexibility in mode of operation and in allowing for differences of management style

TABLE 6.2

CASE STUDY II

I ORGANIZATIONAL CONTEXT

A. Firm

- Non-residential building contractor based in Montreal;
- In business for over 40 years;
- Family owned;
- Specializes in all building projects (commercial, instituional, industrial, high rise residential) over $5 million; has built many in Montreal area.

B. Objectives

- Objectives of firm are: 1) Survival
  2) Development of a reputation for timely completion within budget
- Growth is not an objective
- Specific strategy to obtain objectives: look for work in other markets; extensive attention given to formulation of detailed schedules for projects; use of computerized cost accounting system.

C. Project Staff

- 3 senior executives
- 5 project managers
- 3 estimators (chief estimator is also contracts manager)
- 7 superintendents
- 15 foremen
- total of 130 employees
- Project staff consists of a project manager, one superintendent, one clerk and at least one foreman.

D. Work

- yearly volume $40 million, declined since 1976

- Totally in Eastern Canada; 80% in Montreal area
- has investigated unsuccessfully other markets (Western Canada and Middle East)
- Contracts are 50% fixed price, 25% cost plus, 10% negotiated, and 15% management.
- Moderate portion of work is obtained from repeat business
- When the firm enters into competitive bidding, success rate is one in 20, a 10% success rate is considered excellent.

E. Classification of Decision Types Made by Project Staff for Project Control

Parameters	Senior Management	Project Manager	Estimator	Job Superintendent	Foreman
Strategic Planning	YES	SOME	SOME	NO	NO
Management Control	SOME	YES	SOME	SOME	NO
Operational Control	NO	SOME	NO	YES	SOME

F. Definition of Responsibilities and Policies

- Communication does not follow direct lines of command but takes shortest path
- no written job descriptions except for clerk
- no policy manual outlining procedures to be followed except for note book for the clerk

II. PROBLEM (Project Planning and Control)

A. Characteristics of Average Project

- Value: $15 million
- Duration: 24 months
- Form: mostly multi storey commercial buildings
- Technical complexity: varies from simple to complex (e.g. university building)

- Degree of Definition: usually plans and specifications are complete at the outset
- Familiarity: some similarity between projects; however prepared to undertake projects of varied nature
- Contractual arrangement: fixed price
- Percentage subcontracted: 90 percent
- Total work force at peak: 200 men
- Firm's work force at peak: 25 men

B. Environment

- Location: Montreal
- Client: Private and public entities
- Labour types provided by firm: labour and minimal carpentry
- Materials provided by firm: usually supplies for work done by own forces
- Suppliers: mostly local
- Equipment: firm owns no heavy equipment, when need arises, equipment is rented, subs provide their own equipment
- Subcontractors: mostly local; one subcontractor is a subsidiary company of the firm
- Extras: average value of change order work is 9% of the total value of project

C. Control System

i) Techniques:

- Bar chart consisting of 60 activities; detailed bar charts for each major activity are done with time units down to half days
- Cost code system activity-based
- Computerized cost accounting
- Use CPM only at client's request, but never at site level

ii) Information System:

- Reports from site on time and progress
- Visual inspection
- Information conversations
- Monthly cost reporting done by computer
- Formal weekly meetings

iii) Control Variables:

- Schedule
- Supervision

- Monthly cost summary reports
- Cost to complete report
- Daily reports from subtrades
- Coordination meetings with subtrades and with architect, engineer, client
- Experience from similar jobs

iv) Management Action:

- Coordination of weekly meetings and set tasks
- Measure progress and monitor schedule
- Pursue subs insisting on good quality work and qualified personnel, and maintainance of the schedule
- Expedite material deliveries
- Order subs and own forces to work overtime

III PERSON AND PSYCHOLOGICAL TYPE
with reference to Project Planning and Control

Attributes	Senior Management	Project Manager	Superintendent	Estimator
Age	from 30 and up	all over 40	all over 40	25 to 50
Education	all high school	2 engineers rest high school	all high school or less	all high school.
Experience	on the job training and exposure	exposure to estimating as well as project management	work way up through the ranks	work way up through ranks
Technical Skills	Formal training and evening courses in estimating CPM	2 engineers, others evening courses in estimating and Constr. planning	former carpenters, courses in blueprint reading and estimating	evening courses in blueprint reading and estimating
Communication Skills	mainly verbal	mostly formal some verbal	mainly verbal	verbal and formal
Management Skills	little formal training	little formal training	no formal training	no formal training
Responsibility	ask questions periodically about project progress and review monthly cost report	schedule and control resources and oversee day to day running of project	day to day running of the site activities	prepare estimate and price changes
Openness to New Ideas	limited time devoted to assessing new ideas	limited time devoted to assessing new ideas	limited time devoted to assessing new ideas	limited time devoted to assessing new ideas
Preferred Mode of Evaluation of Problems	judgement based mainly on past experience with some based on facts from reports	judgement based on past experience with some based on present facts	judgement based on past experience	judgement based on past experience
Preferred Mode of Perception of Problems	intuition, informal reports based on past experience some based on facts from reports	intuition, informal reports based on past experience, some based on facts from reports	intuition based on past experience	based on intuition and on previous jobs

IV EVIDENCE AND MODE OF PRESENTATION

A. Information Gathered:

- man hours, equipment hours, material deliveries, job costs, job progress, sub progress, change order work

B. Method of Generating Information:

- reports from site on time and progress
- weekly meetings
- visual inspection monthly cost reports
- informal discussions

C. Mode of presentation:

- Formal: Detailed bar charts, tabular computer processed cost data, job minutes
- Informal: Visual inspection and oral reporting to senior management.

D. Frequency of reporting:

- from site done weekly: reports on time measurement
- at the office cost reports done monthly
- discussions at irregular intervals

V APPARENT PROBLEMS WITH PLANNING AND CONTROL

- Assigning of proper cost codes to activities for proper control and future reference
- Control over subcontractors performance

VI APPARENT STRENGTHS OF FIRM

- Reputation for bringing projects on schedule within budget
- Versatility to handle various types of building projects partly due to keeping of formal records
- Relatively good control over sub trades
- The sense of teamwork that senior management encourages
- The use of tools and techniques for routine reporting

CASE STUDY III

I ORGANIZATIONAL CONTEXT

A. Firm

- Non-residential building contractor based in Montreal;
- began business in residential construction.
- Owned by senior executives
- presently in state of reflection about future market, considering greater involvement in property development and management

B. Objectives

- Objectives of firm are: 1) Survival
  2) development of a reputation for timely completion within budget
- Growth is not an objective
- No specific strategy to obtain objectives

C. Project Staff

- 5 senior executives (2 are retiring)
- 2 project managers (1 is retiring)
- 1 project engineer
- 3 estimators
- Project staff consists of a senior manager who is usually appointed project manager, one superintendent and a foreman for peak periods; for a very large job, a project engineer would be assigned.

D. Work

- yearly volume $10 million to $20 million, declined since 1976
- Totally in the province of Quebec; 95% in Montreal area
- Contracts are 50% fixed price, 45% negotiated, 5% management
- Work is obtained almost totally from repeat business
- When firm enters competitive bidding, success rate is one in 25

E. Classification of Decision Types Made by Project Staff for Project Control

Parameters	Senior Management/Project Management	Project Engineer	Estimator	Job Superintendent
Strategic Planning	YES	NO	NO	NO
Management Control	YES	YES	SOME	SOME
Operational Control	SOME	YES	NO	YES

F. Definition of Responsibilities, Policies

- communication does not follow direct lines of command but takes shortest path
- no written job descriptions
- no policy manual outlining procedure to be followed

II PROBLEM (Project planning and control)

A. Characteristics of Average Project

- Value: $1 million
- Duration: 12 months
- Technical complexity: simple (standard features) e.g. office buildings
- Degree of Definition: at times only conceptually defined at the outset
- Familiarity: New work very similar to previous work
- Contractual arrangement: negotiated
- Percentage subcontracted: 80 percent
- Firm's work force at peak: 12 men

B. Environment

- Location: Montreal
- Client: Private investor
- Labour types provided: labour and some carpentry

- Materials provided by firm: supplies for work done by own forces as well as by some subtrades
- Suppliers: mostly local
- Equipment: firm owns no heavy equipment, when need arises, equipment is rented. Subs provide their own equipment
- Subcontractors: mostly local
- Extras: average number of change orders is 60.

C. Control System

i Techniques:

- Bar chart consisting of approximately 50 activities
- Cost code system activity-based

ii Information System:

- speedy memos when records are necessary at site
- monthly cost reports
- bar chart
- coordination meetings
- visual inspection by senior management from site visits
- verbal reporting

iii Control Variables:

- Schedule
- Supervision
- Monthly cost reports
- Coordination meetings with subtrades and architect engineer, client
- Experience from previous jobs

iv Management Action:

- Coordination of weekly meetings and assignment of tasks
- Measure progress and monitor schedule
- Pursue subs insisting on good quality work and qualified personnel, and maintainance of the schedule

III PERSON AND PSYCHOLOGICAL TYPE
with reference to Project Planning and Control

Attributes	Senior Management Project Management	Project Engineer	Job Superintendent	Estimator
Age	45 to 75	30	50	25 to 45
Education	University graduates Engineering Architecture	University graduate Engineer-Architect	high school	University or college graduates
Experience	on the job training and exposure	4 years with present firm	worked way up through ranks	on the job training and exposure
Technical Skills	civil engineers architect quantity surveyors	Engineer	evening courses, former carpenter	Quantity Surveyor
Communication Skills	some formal some verbal	some formal some verbal	mostly verbal some formal	verbal and formal
Management Skills	no formal training	no formal training	no formal training	no formal training
Responsibility	schedule resources as well as get involved in day to day problems	liaison between site and office	day to day running of site activities	prepare estimate and price changes
Openness to New Ideas	Some dissatisfaction with Status Quo	Still learning process about construction	Satisfied with Status Quo	Satisfied with Status Quo
Preferred Mode of Evaluation of Problems	judgement mainly based on past experience	judgement mainly based on facts from documents	judgement based on past experience	judgement based on available data from previous estimates
Preferred Mode of Perception of Problems	Intuition, based on past experience	Based on data and some intuition	Intuition based on past experience	Intuition and past experience

IV EVIDENCE AND MODE OF PRESENTATION

A. Information Gathered:

- man hours, equipment hours, material deliveries, job progress, changeorders, and sub progress

B. Method of Collecting Information:

- mostly informal, visual inspection preferred
- monthly cost reports are done for purpose of project control
- time charged against cost codes activities
- quantities are measured by visual inspection for progress payments

C. Mode of Presentation:

- Formal: minutes of job site meetings
  speedy memos
  reports of project progress for client
- Informal: Oral reporting from site

D. Frequency of reporting:

- weekly from job site
- monthly for processed information from the office

V APPARENT PROBLEMS WITH PLANNING AND CONTROL

- The flow of decision-making process with regards to change order work
- Delay of progress payments by the owner
- Control of subcontractor performance
- Too much time spent by senior management for site visits; implies little time for planning strategy
- Lack of accuracy in reporting

VI APPARENT STRENGTHS OF FIRM:

- Senior management is directly involved in the running of a project
- Management is able to obtain amount of work which it can execute comfortably
- Management staff are highly qualified, have considerable experience and have worked together for a long time.

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APPENDIX I

QUESTIONNAIRES FOR: SENIOR MANAGEMENT
CONSTRUCTION MANAGER
CHIEF ESTIMATOR
SUPERINTENDENT

Centre des études sur le bâtiment
Centre for Building Studies

Université Concordia, 1455 ouest, boul de Maisonneuve Montréal, Québec, Canada H3G 1M8 téléphone 879-8551
Concordia University, 1455 de Maisonneuve Blvd W Montreal, Que, Canada H3G 1M8 telephone 879-8551

QUESTIONNAIRE FOR SENIOR MANAGEMENT

FOR RESEARCH PROJECT ON CONTROL SYSTEMS

FOR THE MEDIUM-SIZED CONTRACTOR

I. SIZE AND CHARACTER OF THE FIRM AND ITS OBJECTIVES

1. Please indicate which roles your firm typically assumes:

	%
General Contractor	______
Trade Contractor	______
Engineering Contractor	______
Design Build	______
Construction Managment	______
Other (please specify)	
______________	______

2. What is the approximate breakdown of the range of projects undertaken?

	%
Residential	______
Commercial	______
Light Industrial	______
Heavy Industrial	______
Other (please Specify)	
______________	______

.../2

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.../2

3. The average annual volume of the firm at present, in current dollars is:

	%
less than $1 million	______
$1 million to $5 million	______
$5 million to $10 million	______
$10 million to $20 million	______
$20 million to $40 million	______
over $40 million	______

and the average annual rate of growth over the last 3 years has been ______%.

4. At any one time the firm is involved in:

2-5 projects	______
6-10 projects	______
11-15 projects	______
16-20 projects	______
21-30 projects	______
over 30 projects	______

5. The firm's projects range in value from $______ to $______ and in duration from ______ months to ______ months.

..../3

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.../3

6. The geographic distribution of projects is roughly as follows:

	%
Montreal	____
Quebec	____
Quebec and Ontario	____
Eastern Canada	____
Western Canada	____
International	____

7. The mix of contract types the firm is normally engaged in is roughly as follows:

	%
Fixed price	____
Cost plus fixed price	____
Cost plus percentage	____
Negotiated	____
Construction Management	____
Turnkey (Design Build)	____

8. Head office staff consists of ____ people, of which ____ are clerical staff. Site personnel maintained full time by the company include ____ superintendents and ____ foremen.

.../4

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.../4

9. Please sketch the organizational chart for your firm in the space provided below. Please show key personnel, their educational background and lines of authority.

.../5

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.../5

10. With respect to the organization of site management, it is useful to consider projects according to size. Please complete the following table and indicate in the space allotted the typical site organization employed for each project size.

	Project Size		
	Small	Medium	Large
% of total annual projects			
Typical project type (i.e., residential, industrial, commercial, etc.)			
Average value $			
Average duration (months)			
Normal contractual arrangement with owner			
Average project work force size			
Average number of site workers directly on your payroll			
% of work subcontracted and typical number of subs/project			
Nature of work performed by your own forces.			
Average value ($) of change orders as % of average project value ($)			
Maintenance of job records: % at site; % at head office			

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.../6

Typical site staff organizational chart for small size projects
(including interface with head office)

Typical site staff organizational chart for medium size projects
(including interface with head office)

.../7

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.../7

Typical site staff organizational chart for large size projects
(including interface with head office)

.../8

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.../8

11. Listed below are several possible objectives for a construction firm. Please identify, in order of importance, those objectives pursued by your firm.

	Priority
a) Percentage return on volume not less than some predetermined number	____
b) Development of a reputation for timely completion of projects within budget	____
c) Maximization of return on equity	____
d) Attainment of a specified rate of annual growth in dollar volume	____
e) Diversification into other forms of construction	____
f) To become a national construction company	____
g) To become an international construction company	____
h) To become a development company	____
i) Other (please specify)	____

____

____

Without disclosing confidential information, please describe briefly the strategy employed to attain your firm's objectives.

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II MANAGEMENT POLICY AND PRACTICES

(to be completed by way of interview)

1. How do you train and/or upgrade site management personnel to ensure optimum performance?

2. To what extent do you define all the roles of management personnel in terms of their functions, responsibility and authority?

3. Does your firm have a company policy handbook which sets forth the roles of personnel and procedures to be followed? ____

   If yes, who prepares this handbook, how often is it revised and what specific roles and procedures are treated?

4. Please describe what use is made of computers by your firm and the nature of your experience with them.

III ROLE OF SENIOR MANAGEMENT IN INDIVIDUAL PROJECT CONTROL

(to be completed by way of interview)

1. Please describe the role of senior management in individual project control, in terms of control of labour, equipment, materials, change orders, subcontractors, cashflow, productivity, physical progress and time. Issues to be addressed should include information received by senior management, level of detail, format and frequency and decisions made and action initiated by senior management.

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2. Please describe your views regarding the effectiveness of your project control procedures emphasizing both their strengths and weaknesses. Given the availability of funds to improve these practices, please indicate how you would proceed and why.

3. Please rank, in order of importance (most important first), the factors which, from your experience, cause projects to deviate from their intended performance in terms of cost, time and quality.

4. How would you describe the attitude of site management personnel with respect to the need for accurate and timely records on job progress and their role in providing such records?

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QUESTIONNAIRE FOR CONSTRUCTION MANAGER FOR RESEARCH PROJECT ON CONTROL SYSTEMS FOR THE MEDIUM-SIZED CONTRACTOR

Preamble

The objective of our study is to seek ways to strengthen present construction project control practices as they relate to the control of labour, equipment, materials, change orders, subcontractors, physical progress and productivity.

To ensure that the output of our research will serve the needs of the medium-sized contractor, your input with respect to general background information as well as specific details regarding project control practices is essential.

I BACKGROUND INFORMATION

1. With respect to the organization of site management, it is useful to consider projects according to size. Please indicate, in the space allotted, the typical site management organizational structure employed for projects of small, medium and large size, respectively.

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Typical site staff organizational chart for small size projects
(including interface with head office)

Typical site staff organizational chart for medium size projects
(including interface with head office)

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.../3

Typical site staff organizational chart for large size projects (including interface with head office)

2. To assist us in gaining a perspective on the general management practices of your firm, please complete Table I.1.

.../4

TABLE I.1

.../4

QUESTIONS	PROJECT SIZE SMALL	MEDIUM	LARGE
SCHEDULING			
1. Do you prepare a schedule with your estimate? NO YES - a) Using own staff b) Using the assistance of a service bureau c) Using bar charts (not based on CPM) d) Using CPM e) Using other methods.			
2. Do you use schedules during the work? NO YES - a) Bar charts (not based on CPM) b) CPM c) Other types			
3. How often do you update your schedules? a) At regular intervals b) Under special circumstances c) Never			
4. Is your schedule updating done: a) By your head office personnel? b) By your job field personnel? c) By an independent service bureau?			
COST KEEPING			
5. Is your cost accounting separate from your general accounting?			
6. Is your cost accounting system divided: a) Into unit activities? b) Into trades?			
7. Do you keep overhead costs separate?			
8. Do you keep equipment costs separate?			
9. Is your labour cost and payroll: a) Combined? b) Separate?			
10. Do you prepare cost reports: a) Weekly? b) Every two weeks? c) Monthly? d) Periodically?			

.../5

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TABLE I.1 (cont'd)

QUESTIONS	PROJECT SIZE SMALL	MEDIUM	LARGE
11. Do you maintain your job costs: a) On the site? b) In the head office?			
12. Are the accounting items used in your costing: a) Identical to the items in your estimate? b) More detailed than your estimate? c) More general than your estimate?			
13. Do you use computers for: a) Labour payroll? b) Cost accounting? c) General accounting? d) Cashflow forecasting? e) Scheduling? f) Estimating?			
14. Do you prepare a cashflow forecast with your estimate?			
15. Do you prepare a cashflow forecast after being awarded the contract?			
16. Do you update your cashflow forecast during the execution of the project? NO YES - a) At regular intervals b) Under special circumstances			
PROGRESS REPORTING			
17. How often do you receive progress reports from your jobs? a) Weekly b) Every two weeks c) Monthly d) Periodically			
PRODUCTIVITY			
18. Do you maintain productivity figures for major equipment items?			
19. Do you maintain productivity figures for individual trades?			

.../6

...6

3. Please describe the relationship between the work breakdowns used for (i) estimating; (ii) planning and scheduling; and (iii) time and cost control. If the breakdowns are not similar in nature, how do you relate one to another?

II SPECIFIC CONTROL PRACTICES OF THE FIRM

LABOUR

1. With respect to the information gathered regarding labour during the course of a project, please describe:

   a) the specific information collected, who collects it, and in what format(s);

   b) the frequency at which it is collected;

   c) the manner in which it is processed to determine payroll, productivity and labour cost overruns;

   d) the usefulness of the information generated for purposes of control of labour.

2. Please rank, in order of importance (most important first) the factors which, from your experience, make the control of labour difficult.

3. Please describe the strengths and weaknesses of your present labour control procedures. Given the opportunity to modify them, what would you change and why?

EQUIPMENT

1. With respect to the information gathered regarding equipment used during the course of a project, please describe:

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a) the specific information collected, who collects it and in what format(s);

b) the frequency at which it is collected;

c) the manner in which it is processed to determine productivity and costs;

d) the usefulness of the information generated for purposes of control of equipment.

2. Please rank, in order of importance (most important first), the factors which, from your experience, make the control of equipment difficult.

3. Please describe the strengths and weaknesses of your present equipment control procedures. Given the opportunity to modify them, what would you change and why?

MATERIALS

1. With respect to the information gathered regarding materials used during the course of a project, please describe

   a) the specific information collected, who collects it and in what format(s);

   b) the frequency at which it is collected;

   c) the manner in which it is processed to determine costs, quantities used, losses, etc.;

   d) the usefulness of the information generated for purposes of control of materials.

2. Please rank, in order of importance (most important first) the factors which, in your experience, make the control of materials difficult.

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3. Please describe the strengths and weaknesses of your present materials control procedures. Given the opportunity to modify them, what would you change and why?

CHANGE ORDERS

1. With respect to the information gathered regarding change orders which occur during the course of a project, please describe

   a) the specific information collected, who collects it and in what format(s);

   b) the manner in which it is processed.

2. Please rank, in order of importance (most important first) the factors which, in your experience, make the control of cost and time associated with change orders difficult.

3. Please describe the strengths and weaknesses of your present change order control procedures. Given the opportunity to modify them, what would you change and why?

SUBCONTRACTORS

1. With respect to the information gathered regarding the performance of subcontractors during the course of a project, please describe

   a) the specific information collected, who collects it and in what format(s);

   b) the frequency at which it is collected;

   c) the manner in which it is processed to determine subcontractor performance;

   d) the usefulness of the information generated for purposes of control of subcontractors.

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2. Please rank, in order of importance (most important first) the factors which, from your experience, make the control of subcontractors difficult.

3. Please describe the strengths and weaknesses of your present subcontractor control procedures. Given the opportunity to modify them, what would you change and why?

PHYSICAL PROGRESS

1. With respect to the information gathered regarding physical progress during the course of a project, please describe

   a) the basis used for measuring physical progress (e.g., quantities placed, manhours expended, etc.);

   b) the frequency at which progress is measured;

   c) the manner in which information pertaining to progress is processed to determine the extent of project progress;

   d) the usefulness of the information generated for purposes of controlling the rate of progress;

   e) the usefulness of the information generated for purposes of controlling scheduled activity duration.

2. Please describe, in order of importance (most important first) the factors which, from your experience, make the control of physical progress difficult.

3. Please describe the strengths and weaknesses of your present method(s) of measuring physical progress. Given the opportunity to modify them, what would you change and why?

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.../10

III PROFILE OF THE CONSTRUCTION MANAGER

1. Please describe your educational background and professional experience. How long have you been with your present firm?

2. At any one time, how many projects are you responsible for (please specify in terms of number and value).

3. Please describe briefly the total set of functions comprising your position as construction manager.

4. Please describe, in detail, your functions with respect to the control of labour, equipment, materials, change orders, subcontractors, physical progress, productivity and cash flow.

5. What do you see as the functions of the project superintendent and foremen with respect to the control of the items in 4 above?

6. What do you view as the single most important problem area in project control?

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QUESTIONNAIRE FOR CHIEF ESTIMATOR

FOR RESEARCH PROJECT ON CONTROL SYSTEMS

FOR THE MEDIUM-SIZED CONTRACTOR

Preamble

The objectives of our study are to seek ways to strengthen present construction project control practices as they relate to the control of labour, equipment, materials, change orders, subcontractors, physical progress and productivity and to develop information systems which will facilitate effective project control.

To ensure that the output of our research will serve the needs of the medium-sized contractor we require your input. In particular, we are seeking information pertaining to the role of the estimating department in maintaining project control.

I BACKGROUND INFORMATION

1. Please describe the structure and functions of the estimating department in your company.

2. What is your role in these functions, and what are the responsibilities attached to that role?

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3. What specific decisions do you make and what information do you require for these decisions?

4. What are the duties of estimators in your department with respect to individual projects for the various project phases, (i.e. pre-bid or tender phase, post bid or pre-construction, construction, feedback)?

5. Please describe the relationship between the estimating department and the individual project managers.

6. Please describe the relationship between the estimating department and senior management.

7. Please describe the educational background and experience of the various individuals in your department, including yourself.

8. To what extent does the estimating department make use of the computer?

9. Please describe the relationship between the work breakdowns used for (i) estimating; (ii) planning and scheduling, and (iii) time and cost control. If the breakdowns are not similar in nature how do you relate one to the other?

10. With respect to the work breakdowns for the phases mentioned in (9), what level of detail is used and what standard breakdown formats, if any, are followed (e.g. U.C.I. format)?

11. What is the role of the estimating department with respect to purchasing and expediting?

12. How are the procedures and practices of the estimating department influenced by projects of large size and/or when the company has several projects ongoing simultaneously?

13. What do you view as the single most important problem area in project estimating, planning and control?

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II EXAMINATION OF SPECIFIC ESTIMATING DEPARTMENT FUNCTIONS

PLANNING AND ESTIMATING

Please describe the functions of the estimating department with respect to project planning and estimating in terms of:

a) the information gathered and processed by the estimating department, and the manner in which it is presented and used;

b) major problem areas as you see them and actions you suggest that may strengthen the present project planning and estimating practices of your department.

SCHEDULING

Please describe the functions of the estimating department with respect to scheduling in terms of:

a) The information gathered and processed by the estimating department, and the manner in which it is presented and used.

b) From your experience, are the schedules prepared by your department closely adhered to throughout the project? Are you responsible for updating project schedules and if yes, how often on average is the schedule updated?

c) Please express your views regarding the use of the bar chart and CPM for planning and scheduling.

d) Major problem areas as you see them and actions you suggest that may strengthen the present scheduling practices.

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COST RECORDS

INDIRECT COSTS

DIRECT COSTS (LABOUR - MATERIAL - EQUIPMENT)

Please describe the functions of the estimating department with respect to cost records in terms of:

a) Cost information gathered and processed by the estimating department and the manner in which it is presented and used.

b) Major problem areas as you see them, and actions you suggest that may strengthen the present practices of keeping cost records.

PHYSICAL PROGRESS (MEASUREMENT OF PERCENTAGE COMPLETE)

Please describe the functions of the estimating department with respect to control of physical progress in terms of:

a) The information gathered and processed by the estimating department and the manner in which it is presented and used.

b) Major problem areas as you see them and actions you suggest that may strengthen the present practices of monitoring and control of physical progress.

PRODUCTIVITY (LABOUR - EQUIPMENT)

1. Please describe the functions of the estimating department with respect to the control of productivity in terms of:

a) The information gathered and processed by the estimating department and the manner in which it is presented and used.

b) Major problem areas as you see them and actions you suggest that may strengthen the present practices for measuring and controlling productivity.

2. Please describe the role of productivity data from previous jobs in the estimating of new work and the control of ongoing work.

CHANGE ORDERS

Please describe the functions of the estimating department with respect to the control of change orders in terms of:

a) The information gathered and processed by the estimating department and the manner in which it is presented and used.

b) Major problem areas as you see them and actions you suggest that may strengthen the present change order control practices.

SUBCONTRACTORS

Please describe the functions of the estimating department with respect to the control of subcontractors in terms of:

a) The information gathered and processed by the estimating department and the manner in which it is presented and used.

b) Major problem areas as you see them and actions you suggest that may strengthen the present subcontractor control practices.

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QUESTIONNAIRE FOR SUPERINTENDENT
FOR RESEARCH PROJECT ON CONTROL SYSTEMS
FOR THE MEDIUM-SIZED CONTRACTOR

Preamble

The objective of our study is to seek ways to strengthen present construction project control practices as they relate to the control of labour, equipment, materials, change orders, subcontractors, physical progress and productivity.

To ensure that the output of our research will serve the needs of the medium-sized contractor, your input with respect to general background information as well as specific details regarding project control practices is essential.

I BACKGROUND INFORMATION

1. Please describe briefly the functions attached to your position as project superintendent.

2. Please describe your educational background and professional experience. How long have you been with your present firm?

3. To what size projects (describe in terms of cost and duration) are you typically assigned?

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.../2

4. Please sketch below the typical site management organizational structure employed on the projects with which you have been associated.

.../3

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.../3

II - SPECIFIC CONTROL FUNCTIONS OF THE SUPERINTENDENT

1. Please describe your functions with respect to the control of labour, equipment, materials, change orders, subcontractors, physical progress and productivity in terms of:

   (a) a general description of your specific role in the control of each item;

   (b) the data you collect and the forms you complete;

   (c) the use made of the reports you are required to make;

   (d) the feedback you receive (in terms of reports, updated schedules, etc);

   (e) the usefulness of the reports you make and receive for control;

   (f) major problems as you see them with respect to the control of each item;

   (g) what actions you would suggest being taken in order to strengthen present control practices.

2. What do you see as the functions of the construction manager and the job foreman with respect to the control of labour, equipment, materials, change orders, subcontractors, physical progress and productivity?

3. What do you view as the single most important problem area in project control?

APPENDIX II

LIST OF ACTIVITIES RELATED TO BUILDING CONSTRUCTION

APPENDIX II

LIST OF ACTIVITIES RELATED TO BUILDING CONSTRUCTION

01.000 - General Requirements

- 01.100 - Overhead
  - 01.105 - Insurance
  - 01.110 - Main office expense
  - 01.115 - Performance bond
  - 01.120 - Permits
  - 01.125 - Photographs
  - 01.130 - Safety features
  - 01.135 - Temporary enclosures
  - 01.140 - Testing
  - 01.145 - Watchmen
  - 01.150 - Scheduling
  - 01.155 - Overhead and profit
- 01.500 - Contractor Equipment
  - 01.505 - Mobilization charges

02.000 - Site Work

- 02.100 - Exploration and Clearing
  - 02.105 - Clear and grub
  - 02.110 - Disposal
- 02.200 - Earthwork
  - 02.205 - Bulk excavation
  - 02.210 - Structural excavation
  - 02.215 - Trench excavation
  - 02.220 - Hand excavation
  - 02.225 - Drill and blast
  - 02.230 - Sheet piling
  - 02.235 - Shoring
  - 02.240 - Wellpoints
  - 02.245 - Horizontal boring
  - 02.250 - Dewater
  - 02.255 - Chemical grouting
  - 02.260 - Pressure grouting

02.265 - Hauling
02.270 - Borrow
02.275 - Backfill
02.280 - Fill
02.285 - Compaction
02.290 - Grading

02.400 - Caissons and Piling

02.405 - Caissons
02.410 - Concrete piles
02.415 - Steel piles
02.420 - Wood piles

02.500 - Site drainage and utilities

02.505 - Catch basins and manholes
02.510 - Excavation and backfill (for pipe)
02.515 - Gravel fill (for trench)
02.520 - Gas service and distribution
02.525 - Pipe drainage and sewage
02.530 - Subdrainage (foundation under drains)
02.535 - Piping, water distribution systems
02.540 - Septic tanks

02.600 - Roads and Walks

02.700 - Site improvements

02.800 - Lawns and Planting

03.000 - Concrete

03.100 - Formwork

03.105 - Wall footings
03.110 - Spread (column) footings
03.115 - Foundation walls and grade beams
03.120 - Restoring
03.125 - Set anchor bolts
03.130 - Clean and oil forms
03.135 - Suspended slab
03.140 - Walls
03.145 - Columns
03.150 - Beams
03.155 - Stairs
03.160 - Bulkheads

03.165 - Waterstops
03.170 - Expansion joints
03.175 - Inserts
03.180 - Screeds
03.185 - Stripping forms

03.200 - Reinforcing Steel

03.205 - Wall footings
03.210 - Spread footings
03.215 - Foundation walls and grade beams
03.220 - Suspended slabs
03.225 - Walls
03.230 - Columns
03.235 - Beams
03.240 - Stairs

03.300 - Cast-in-Place Concrete

03.305 - Wall footings
03.310 - Spread footings
03.315 - Foundation walls and grade beams
03.320 - Suspended slab
03.325 - Walls
03.330 - Columns
03.335 - Beams
03.340 - Stairs

03.400 - Precast Concrete

03.405 - Precast concrete panels
03.410 - Precast structural concrete
03.415 - Precast prestressed concrete

04.000 - Masonry

04.200 - Brick Masonry

04.205 - Exterior face brick
04.210 - Interior face brick
04.215 - Backup brick
04.220 - Chimney

04.300 - Block and Tile Masonry

04.305 - Exterior concrete blocks
04.310 - Interior concrete blocks
04.315 - Glazed concrete blocks

04.400 - Stone work

04.405 - Machined stone
04.410 - Field stone

04.500 - Siliconing

04.600 - Dampproofing

05.000 - Metals

05.100 - Structural Metals

05.105 - Structural steel columns
05.110 - Structural steel beams
05.115 - Structural steel trusses
05.120 - Strucutral steel bracing

05.200 - Metal Joists and Decks

05.205 - Roof decking
05.210 - Floor decking
05.215 - Open web joists

05.400 - Miscellaneous and Ornamental Metals

05.405 - Decorative covering
05.410 - Access doors (for plumbing etc.)
05.415 - Metal stairs and ladders
05.420 - Handrails and railings
05.425 - Floor grating

06.000 - Wood and Plastics

06.100 - Rough Carpentry

06.105 - Wall framing
06.110 - Framing joists and beams
06.115 - Framing rafters
06.120 - Furring or strapping
06.125 - Sheathing roof and floors
06.130 - Sheathing walls
06.135 - Other rough wood carpentry

06.200 - Finish Carpentry

06.205 - Cabinets
06.210 - Paneling

06.215 - Stairs
06.220 - Siding
06.225 - Casings, moldings, baseboards

06.300 - Laminated Construction

07.000 - Moisture Protection

07.100 - Waterproofing (other than roofing)

07.200 - Insulation

07.205 - Building insulation
07.210 - Roof and deck insulating
07.215 - Perimeter and underslab insulation

07.300 - Shingles

07.400 - Roofing and Siding

07.405 - Roofing (other than built up)
07.410 - Siding

07.500 - Built up Bituminous Roofing

07.600 - Sheet Metal Work

07.605 - Sheet metal roofing
07.610 - Flashing and trim
07.615 - Gutters

07.800 - Roof Accessories

07.805 - Skylights
07.810 - Access doors

08.000 - Doors and Windows

08.100 - Doors and Frames Metal (Fire rated)

08.200 - Wood and Plastic Doors and Wood Frames

08.300 - Special Doors (overhead type)

08.400 - Entrances and Store Fronts

08.500 - Windows

08.600 - Finish Hardware

08.800 - Glass and Glazing

08.900 - Window walls and Curtain Walls

09.000 - Finishes

09.100 - Lath and Plaster

09.200 - Partition Walls

09.300 - Tile and Terrazzo

09.305 - Ceramic tile
09.310 - Marble
09.315 - Quarry mosaics (walls)
09.320 - Metal tile (walls)
09.325 - Terrazzo
09.330 - Paving brick (floor)

09.500 - Acoustical treatment

09.505 - Acoustical tile
09.510 - Suspended ceilings
09.515 - Sprayed or acoustic

09.600 - Flooring

09.605 - Carpentry
09.610 - Resilient flooring
09.615 - Wood flooring

09.800 - Painting and Wall Covering

09.805 - Interior painting
09.810 - Exterior painting
09.815 - Wall covering

10.000 - Specialties

11.000 - Equipment

12.000 - Furnishings

13.000 - Special Construction

14.000 - Conveying Systems

14.100 - Elevators

14.200 - Escalators

15.000 - Mechanical

15.100 - Plumbing

15.105 - Drains
15.110 - Fixtures
15.115 - Piping and valves
15.120 - Pumps
15.125 - Water coolers
15.130 - Water supply meters

15.500 - Fire Extinguishing Systems

15.505 - Automatic fire suppression systems
15.510 - Fire extinguishers
15.515 - Fire hose equipment
15.520 - Fire pump
15.525 - Sprinkler system

15.600 - Heating

15.605 - Boilers
15.610 - Duct furnaces
15.615 - Duct heaters
15.620 - Heating and ventilating units
15.625 - Hot water heating
15.630 - Humidifiers
15.635 - Insulation
15.640 - Tanks

15.700 - Air Conditioning and Ventilating

15.705 - Duct work
15.710 - Diffusers and grilles
15.715 - Fans
15.720 - Air conditioners
15.725 - Ventilators
15.730 - Filters

16.000 - Electrical

16.100 - Lighting

16.105 - Interior lighting fixtures
16.110 - Exit lights and emergency lighting
16.115 - Exterior fixtures
16.120 - Lamps

16.200 - Pull Boxes and Raceways

16.205 - Wall conduit
16.210 - Conduit in concrete slab
16.215 - Conduit in trench
16.220 - Electrical ducts

16.300 - Wire and cable

16.305 - Power wiring
16.310 - Lighting wiring
16.315 - Alarm wiring

16.400 - Grounding

16.500 - Starters, Boards, Switches

16.505 - Motor starters and controls
16.510 - Panel boards
16.515 - Switch boards and instruments
16.520 - Circuit brakers

16.600 - Transformers

16.700 - Generators

16.800 - Special Systems (fire alarm system)

16.900 - Electric & Telephone Site Work

APPENDIX III

TYPES OF NON-RESIDENTIAL BUILDINGS

APPENDIX III

Types of buildings in each category are as follows:

(a) Industrial buildings: Factories, plants, workshops food canneries, smelters, mine and mine mill buildings, railway stations, railway shops, engine houses, water and fuel stations etc.

(b) Commercial buildings: Warehouses, storehouses, refrigerated storage buildings, grain elevators, hotels, clubs, restaurants, cafeterias, motels, office buildings, retail and wholesale stores, shopping centres, garages, service stations, theatres, arenas, amusement and recreational buildings, laundries etc.

(c) Institutional buildings: Educational buildings (schools, universities etc.), churches and other religious buildings, hospitals, sanatoria, clinics, first aid stations, homes for the aged, penetentiaries, jails, etc.

(d) Other non-residential buildings: Farm buildings (excluding dwellings), broadcasting, radio and television, relay and booster stations, airplane hangars, passenger terminals (bus, boat, air and other), armouries, barracks, drill halls, bunhouses, dormitories, camp cookeries, bush depots, camps, laboratories etc.

APPENDIX IV

QUESTIONNAIRES ON: CAUSES OF DELAY

CAUSES OF COST OVERRUNS

CAUSES OF DELAY

Listed below are several items which are considered to be important factors in influencing the progress of construction projects.

Please indicate the effects of these factors in delaying your projects in the following manner:

Circle the letters V.I.	to indicate that this item is a very important factor in delaying the progress of projects in which you are involved.
Circle the letter I.	to indicate an important factor in delay of the progress in construction (but not the most important factor).
Circle the letters M.I.	to indicate minor importance on delay (but does contribute to delaying the project).
Circle the letters N.S.	to indicate no significance (not a factor that delays your projects).

PART 1

(1) WEATHER - What effect does weather have in causing delays to your construction projects?

V.I. I. M.I. N.S.

(2) LABOUR - What effect does the supply of labour have in causing delays to your construction projects?

V.I. I. M.I. N.S.

(3) LABOUR PRODUCTIVITY - What effect does labour productivity have in causing project delays?

V.I. I. M.I. N.S.

(4) MATERIAL - To what extent do shortages of construction materials cause delays to your projects?

V.I. I. M.I. N.S.

(5) EQUIPMENT - What effect does equipment failure have in delaying your projects?

V.I. I. M.I. N.S.

(6) LATE DELIVERIES - What effect do late deliveries of materials and equipment have in delaying your projects?

V.I. I. M.I. N.S.

(7) FINANCES - How important is financing in causing delays to your projects?

V.I. I. M.I. N.S.

(8) MANUFACTURED ITEMS - How significant are items manufactured off the site in causing delays?

V.I. I. M.I. N.S.

(9) MISTAKES - How important are errors committed during field construction at the job site in causing delays to your projects?

V.I. I. M.I. N.S.

(10) DESIGN CHANGES - How important are design changes by the owner or his agents in causing delays to your projects?

V.I. I. M.I. N.S.

(11) FOUNDATION CONDITIONS - How important are foundation conditions encountered at the construction site in delaying progress?

V.I. I. M.I. N.S.

(12) PERMITS - What effect does the obtaining of permits from the municipal authorities (local, county, provincial, federal other) have in delaying your projects?

V.I. I. M.I. N.S.

(13) SHOP DRAWINGS - What effect does the preparation and approval of shop drawings have in causing delays to your project?

V.I. I. M.I. N.S.

(14) SAMPLE APPROVALS - What effect does the waiting for sample material approvals have in delaying your projects?

V.I. I. M.I. N.S.

(15) CODES - What effect does the building code have in causing delays to your projects?

V.I. I. M.I. N.S.

(16) SUBCONTRACTORS - What effects do subcontractors have in causing delays to your projects?

V.I. I. M.I. N.S.

(17) CONTRACTS - What effects do the negotiations and obtaining of contracts have in delaying your projects?

V.I. I. M.I. N.S.

(18) DISPUTES - What effects do jurisdictional disputes have in delaying your projects?

V.I. I. M.I. N.S.

(19) INSPECTION - Some projects require field or laboratory tests such as pile test, concrete tests, x-ray analysis, etc. To what extent does inspection and testing delay your projects?

V.I. I. M.I. N.S.

(20) PLANNING AND SCHEDULING - Are insufficiently detailed plans and schedules a cause of delay?

V.I. I. M.I. N.S.

(21) UPDATING - Is insufficient attention given to updating the schedule in order to permit corrective action to be taken in a timely manner a cause of delays?

V.I. I. M.I. N.S.

(22) COMMENTS - Please indicate any other factors that result in delays on your projects.

FACTOR				
________	V.I.	I.	M.I.	N.S.
________	V.I.	I.	M.I.	N.S.
________	V.I.	I.	M.I.	N.S.

PART 2

Please rank, in order of significance, (most significant first) the five most important factors which cause delays in your projects.

1. ________________
2. ________________
3. ________________
4. ________________
5. ________________

PART 3

Please circle the most appropriate description of your role within the firm.

Senior Management (Specify)

Project Manager

Project Engineer

Estimator

Superintendent

Assistant Superintendent

Foreman

CAUSES OF COST OVERRUNS

Listed below are several items which are considered to be important factors in causing cost overruns in construction projects.

Please indicate the effects of these factors in causing cost overruns in your projects in the following manner:

Circle the letters V.I.	to indicate that this item is a very important factor in causing cost overruns in projects in which you are involved.
Circle the letter I.	to indicate an important factor in cost overruns (but not the most important factor)
Circle the letters M.I.	to indicate minor importance in cost overruns (but does contribute to overruns).
Circle the letters N.S.	to indicate no significance (not a factor in cost overruns in your projects).

PART 1

(1) WEATHER - What effect does weather have in causing project cost overruns?

V.I. I. M.I. N.S.

(2) LABOUR PRODUCTIVITY - What effect does the inability to predict labour productivity accurately have on cost overruns on your projects?

V.I. I. M.I. N.S.

(3) ESCALATION - Are cost increases due to unanticipated price escalations in the following items important determinants of project cost overruns?

(a) Wage Escalation

V.I. I. M.I. N.S.

(b) Materials Escalation

V.I. I. M.I. N.S.

(c) Equipment Escalation

V.I. I. M.I. N.S.

(d) Cost of Financing Escalation

V.I. I. M.I. N.S.

(4) TIME DELAYS - How significant are increased indirect costs due to time delays with respect to cost overruns?

V.I. I. M.I. N.S.

(5) DESIGN DOCUMENTS - What effect do incomplete or vague plans and specifications have on project cost overruns?

V.I. I. M.I. N.S.

(6) CONTRACTS - What effect do imprecise contract clauses (client - general contractor, general contractor - subcontractor) have on project cost overruns?

V.I. I. M.I. N.S.

(7) EXTRAS - Does insufficient documentation justifying costs of extras result in cost overruns on your projects?

V.I. I. M.I. N.S.

(8) SUBCONTRACTORS - Do disputes with subcontractors result in cost overruns on your projects?

V.I. I. M.I. N.S.

(9) WASTAGE - What effect does material wastage have on project cost overruns?

V.I. I. M.I. N.S.

(10) THEFT - What effect does theft of material and small tools and equipment have on project cost overruns?

V.I. I. M.I. N.S.

(11) QUALITY CONTROL - Are problems of quality control a source of cost overruns on your projects?

V.I. I. M.I. N.S.

(12) MISTAKES - How important are errors committed during field construction at the job site in causing cost overruns on your projects?

V.I. I. M.I. N.S.

(13) ESTIMATING - How important are errors in estimating in identifying sources of cost overruns on your projects?

V.I. I. M.I. N.S.

(14) COST CONTROL - Are your present job cost accounting and control practices a source of cost overruns?

V.I. I. M.I. N.S.

(15) COST CODE ASSIGNMENT - Is inaccurate assignment of costs to cost codes a source of cost overruns on your projects?

V.I. I. M.I. N.S.

(16) COMMENTS - Please indicate any other factors which, from your experience, cause cost overruns on your projects.

FACTORS				
________	V.I.	I.	M.I.	N.S.
________	V.I.	I.	M.I.	N.S.
________	V.I.	I.	M.I.	N.S.

PART 2

Please rank, in order of significance (most significant first) the five most important factors which cause delays in your projects.

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________

PART 3

Please circle the most appropriate description of your role within the firm.

Senior Management (Specify)

Project Manager

Project Engineer

Estimator

Superintendent

Assistant Superintendent

Foreman

APPENDIX V

ROLES OF MANAGEMENT PERSONNEL

APPENDIX V

ROLES OF MANAGEMENT PERSONNEL

The President and General Manager

The president and general manager is the highest authority of a company and carries the final responsibility in both internal and external matters for the firm. In organizations of larger size, this responsibility may be shared by two individuals; however for the medium-sized general contractor one person usually handles everything. Most likely, this person is the owner of the firm. The individual holding this position is usually a broadly trained engineer or former tradesman, who has been exposed to many aspects of management either while working for other firms or while building up his own firm, or both.

The duties and responsibilities of the president and general manager may be summarized as follows:

(i) establishment of company policy and company objectives and the ensuring of their attainment

(ii) selection of markets in which the company will operate;

(iii) procurement of capital required for operation by maintaining close contact with bank managers, financiers and insurance brokers.

(iv) development of the company's structure, definition of managment functions and delegation of duties and responsibilities by:

a) Acquiring capable mangement personnel to supervise departmental operations

b) Preparing job descriptions outlining the duties and responsibilities of each member of management

c) Monitoring the performance of each department manager to ensure that the company's objectives are realized

(v) Determination of procedures required for company management and the establishment of management practices and administration systems by:

a) Defining and documenting the administrative systems and procedures necessary for the performance of departmental functions

b) Implementing these administrative systems and monitoring their performance in order to be certain of their effectiveness.

(vi) Establishment of management control measures and evaluation techniques (records, charts, reports, schedules) in order to monitor the functional performance of each department as well as the integrated performance of all the departments in the company.

(vii) Assembly of all documents for the submission of a bid on new work.

(viii) Conduct regular executive committee meetings with department heads to review operations in each department and introduce management recommendations to improve overall company performance.

<u>The Finance Manager</u> (Secretary-Treasurer)

The finance manager is the individual whose tasks are basically to measure the financial pulse of a company. This position requires that he take responsibility for the negotiation and administration of loans; the establishment of accounting systems and record-keeping procedures, and the implementation of expense, budget, wage and salary controls. For the medium-sized contractor, the finance manager should be preferably a chartered accountant who possesses a number of years of working experience. His staff must execute the work with considerable accuracy. For his operations he is responsible directly to the general manager.

In more detail, some of the duties and responsibilities of the finance manager may be summarized as follows:

- Establish mechanisms for satisfying company financial requirements through business loans, suppliers' and subcontractors' credit, construction loans, and such other sources as are deemed necessary.
- Establish procedures to maintain the sound financial balance

between capital investment and indebtedness

- Establish ways and means to increase the efficiency of working capital and to reduce indebtedness to a practical minimum.
- Establish an accounting system with supporting records to monitor and safeguard the financial position of the company.
- Prepare monthly cashflow statements showing the current financial status of the company
- Prepare statements projecting the anticipated future earnings and financial position of the company
- Establish control measures to monitor the cash and profit condition of the company
- Prepare quarterly and annual operational budgets based on construction expense estimates and overhead estimates
- Establish monthly direct and indirect expense budgets based on budgeted direct and indirect costs; and consequently establish a working capital budget
- Provide department heads with monthly budgetary performance reports
- Establish work schedules as well as schedule of wages and salaries
- Attend weekly executive committee meetings

The Construction Manager

The construction manager is the individual in command of construction projects from their inception to their completion. Next to that of the president and general manager, his role is the most prominent in the company, since he directs the actual production. His main responsibilities lie in the planning and and organization of construction operations and the monitoring of their actual performance. His position requires that he act as a co-ordinator whose role is twofold:

1) To provide the link between the firm and external entities such as the client, the architect, the engineer, the suppliers and the subcontractors.
2) To provide the link between the construction site and the office.

He is responsible for the generation of all information from construction projects during their execution.

The person holding this position would usually be an engineer who has a fair amount of construction experience and well known for his ability to make quick, on the spot decisions. He would report directly to the general manager for his operations.

In more detail some of the duties and responsibilities of the construction manager may be summarized as follows:

- Approve all construction plans and specifications prior to start of construction (as to their constructability)
- Maintain and monitor production controls and schedules

- Conduct periodic field inspections of all work under construction and make necessary recommendations
- Gather all field information required, approve it, and distribute it to proper departments
- Attend weekly executive committee meetings to co-ordinate construction activities with the work of other departments
- Approve all subcontractor and supplier invoices
- Supervise quality control inspection of subcontractor services and supplier materials
- Determine the need and timing for the lease and procurement of all construction equipment and negotiate the conditions
- Maintain an equipment register, and prepare monthly cost analysis reports on the maintenance and usage of the equipment
- Furnish each subcontractor and supplier with written specifications for work and material requirements and inspect the performance to ensure that they abide by the set specifications
- Maintain safety regulations at the construction site and coordinate security patrols for the protection of company property
- Prepare a monthly directory of subcontractors and suppliers, and distribute it to all department managers
- Furnish the Finance manager with the following:

  a) information required for accounting records

b) information on inventories of materials, work in progress, and construction equipment

c) construction schedules and information on completion of construction

- Provide the client with the quality of work which meets the requirements of his engineer, or architect or both.

<u>The Chief Estimator</u>

The chief estimator is usually delegated the responsibility of investigating the flexibility of the acquisition of new business by the firm. Consequently he is responsible for the submittal of bids for predetermined deadlines; this requires that he work under a certain amount of pressure. His position demands that he have considerable knowledge of wage rates, productivity rates and equipment technology particularly for the locations in which the contractor operates. His career probably began as a job superintendent, engineering technologist or engineer, most likely civil; his experience was accumulated by previously filling most of the positions in the estimating department. His staff consists mainly of take-off men, costing men, and estimators; the number of individuals varying depending on the volume of the company. For his operations he is directly responsible to the general manager.

In more detail some of the duties and responsibilities of the chief estimator may be summarized as follows:

1) Assess the feasibility of execution of new construction projects by the company

2) Prepare the pre-tender estimate by:
   a) verifying that the contract can be completed reasonably in accordance with the requirements of the client; particularly with regards to completion dates
   b) examining all specifications and noting areas of possible difficulties.
3) Oversee the preparation of detailed estimates done just prior to construction phase
4) Formulate contractural agreements with sub-contractors and suppliers
5) Procures bonds and insurance for projects
6) Establish budgetary cost controls for each job before the start of construction, monitors the actual costs against the budgeted costs and recommends construction improvements to to reduce costs.
7) Establish a change order control system to monitor the processing of contruction changes and to coordinate the flow of these change orders with finance and construction personnel, in a manner which prevents field delays
8) Develop an Evaluation data bank which measures and records productivity rates and costs of various items. This is to be used in future estimating especially for control of cost, time and content.
9) Attend weekly executive committee meetings

The Project Superintendent

The project superintendent is responsible for the actual execution of a particular construction project. Accordingly much of the success in the performance of a project is directly dependent on his abilities. His position requires that he have a strong character and confidence in his know-how, since he makes decisions by the hour. An individual would normally be appointed to this position on account of his extensive experience and his ability to write reports, learn quickly, and solve problems. Generally a project superintendent is a former tradesman capable of organizing work for men and reading drawings very well; however he may be more effective at his job if he possesses formal academic technical knowledge similar to that of an engineer or a technologist. He is the main source for generating information on project status to the main office so that the latter can proceed with the masonry action. For his functions, the project superintendent is directly responsible to the construction manager; in turn reporting to him, he would have the general foreman on the job as well as the superintendents of the subtrades who need to receive his final approval for work executed.

In more detail some of the duties and responsibilties of the project superintendent may be described as follows:

- To direct men employed by the contractor in the most efficient way and to set up the order of work and determine the size of crews to be used in each task

- To observe the execution of work
- To check drawings and make spot-checks to determine that work of subtrades is being done properly
- To review foreman's time reports, for the number of men reported and to see that costs of the work were charged to the proper item
- To inspect incoming materials for quality and quality needed
- To schedule the subcontractors within the general framework planned by the construction manager and to determine if the subcontractors' men are conforming to the requested schedule.
- To inspect subcontractors' work for quality and compliance with the plans and specifications
- To enforce all safety rules, of both his own men and the subcontractor
- To formulate regular reports on quality and percentage of work completed in each cost control category or to direct the foreman to do so, and communicate all possible information to the main office from site operations
- To assure that materials are ordered as needed and that delivery to the job is requested in time to keep the men working without interruption.
- meet periodically with construction manager and other managers reporting on the status of the project and strategizing on future operations.

In addition he must keep a diary to aid him in relating information to the head office which would include the following:

- the starting date of preliminary operations on the new job site
- the weather; this is important because of unavoidable delays that may effect the completion date of the project.
- the number of men employed each day by trades and operations
- Extras ordered by engineer, architect, or owner
- The arrival and completion dates of subtrades and the number of tradesmen on the job. It is imperative that these men complete their work on schedule.
- Inspections by engineers, architects, the city, or other authorized agency
- Notification of readiness for progress inspections to the main office
- Overtime, numbers of men by trades and number of subtradesmen. Reason for overtime
- Rental equipment by types on the job; also the date and hour of arrrival and departure
- Own equipment and machinery on the job by the date and hour
- Accidents that happen on the job
- Notations to office to expedite materials urgently required
- Names and details of important visitors

The Foreman

The foreman is the link between the on-site workmen, and the administrative staff of the company. On large projects, or projects where a large amount of work is executed by the contractors' own forces, he may be in charge of several areas, having under him trade foremen to alleviate the work load. On smaller projects, or projects where most of the work is subbed out he may be placed in charge of supervision of many trades, having only journeymen working under him. The foreman is directly responsible to the project superintendent for his operations. He is usually chosen from the ranks of carpenters, because they are more intimately associated with all other trades on the job including subtrades. He should be a potential superintendent and be able to handle men with fairness and without favour. He must also be able to express himself verbally and in writing, and must be able to read blueprints quite well. He should be well informed on the immediate job-site policy, and if at all possible he should keep himself up-to-date by reading and attending courses of instruction in his field.

Some of the major duties and responsibilities of the foreman are:

(i) to complete daily time sheets of men, showing what phase of construction they worked in

(ii) to determine the placement of newly hired men as soon as the latter arrive at work

(iii) to procure the material and equipment needed by his men, so that no time is lost in execution of work due to delays

(iv) to choose the men to work overtime

(v) to make sure that his part of the work is done by his men according to plans and specifications, yet with the minimum resources.

(vi) to receive work orders from the superintendent, and to return them when the work is completed.