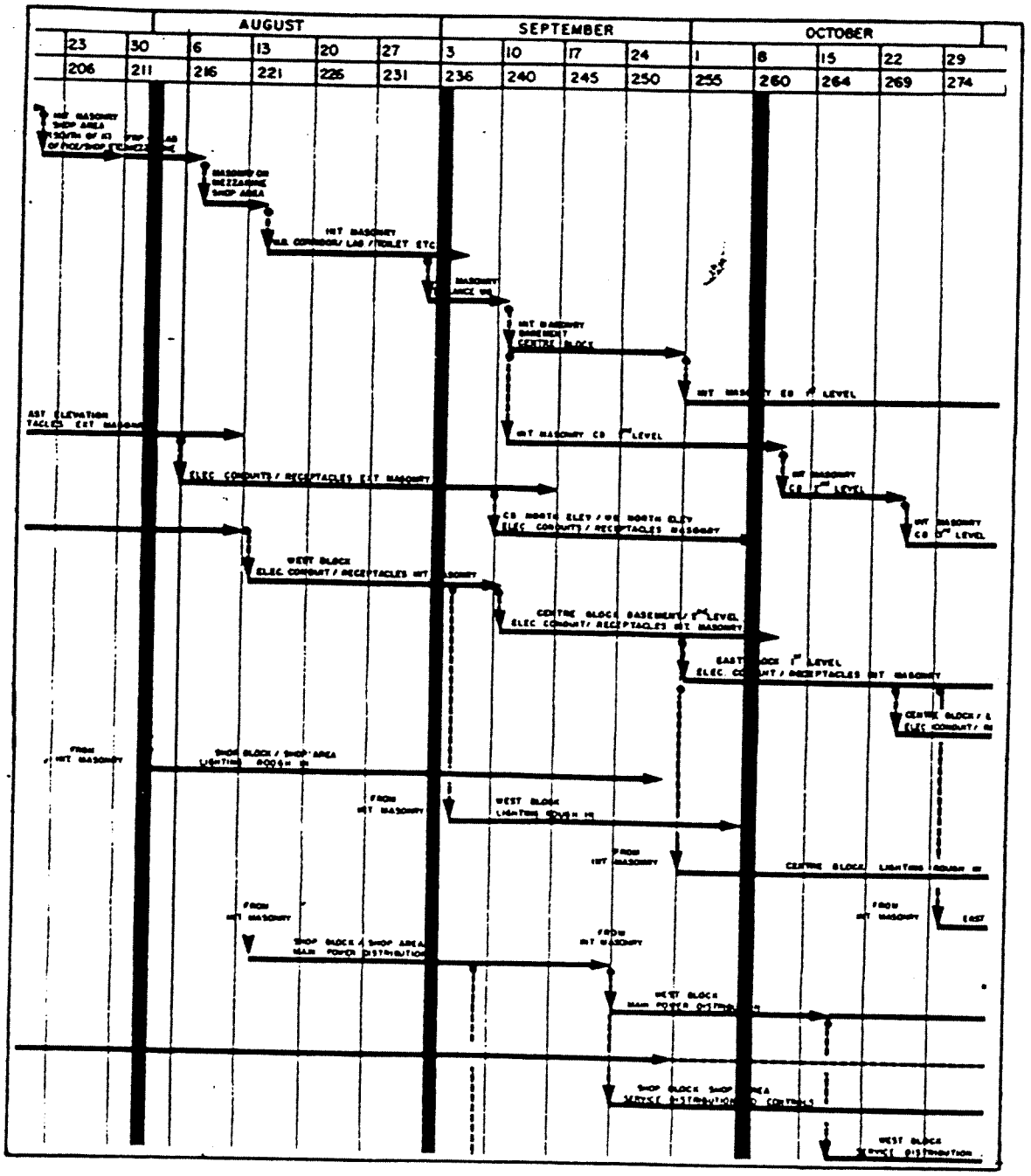


FIGURE 5 MASTER SCHEDULE FORMAT

island. Generally, large firms from the mainland have had difficulties in understanding the local environment and thus have not been able to compete successfully with the local specialists.

The provincial government will nevertheless hire offshore consultants if deemed advantageous to the success of the project, but usually on a single-project basis and with the understanding that the consultants will work closely with local firms. Additionally, the consultants are expected not only to perform their duties but at the same time act as importers of more advanced technology for the future benefit of the local specialists and the island.

If some of the newer project management buzzwords do not form part of the standard vocabulary of a Newfoundland project manager, those must initially be avoided or else they only cause embarrassment or antagonism. However, this ought not to hinder application of modern techniques. Once

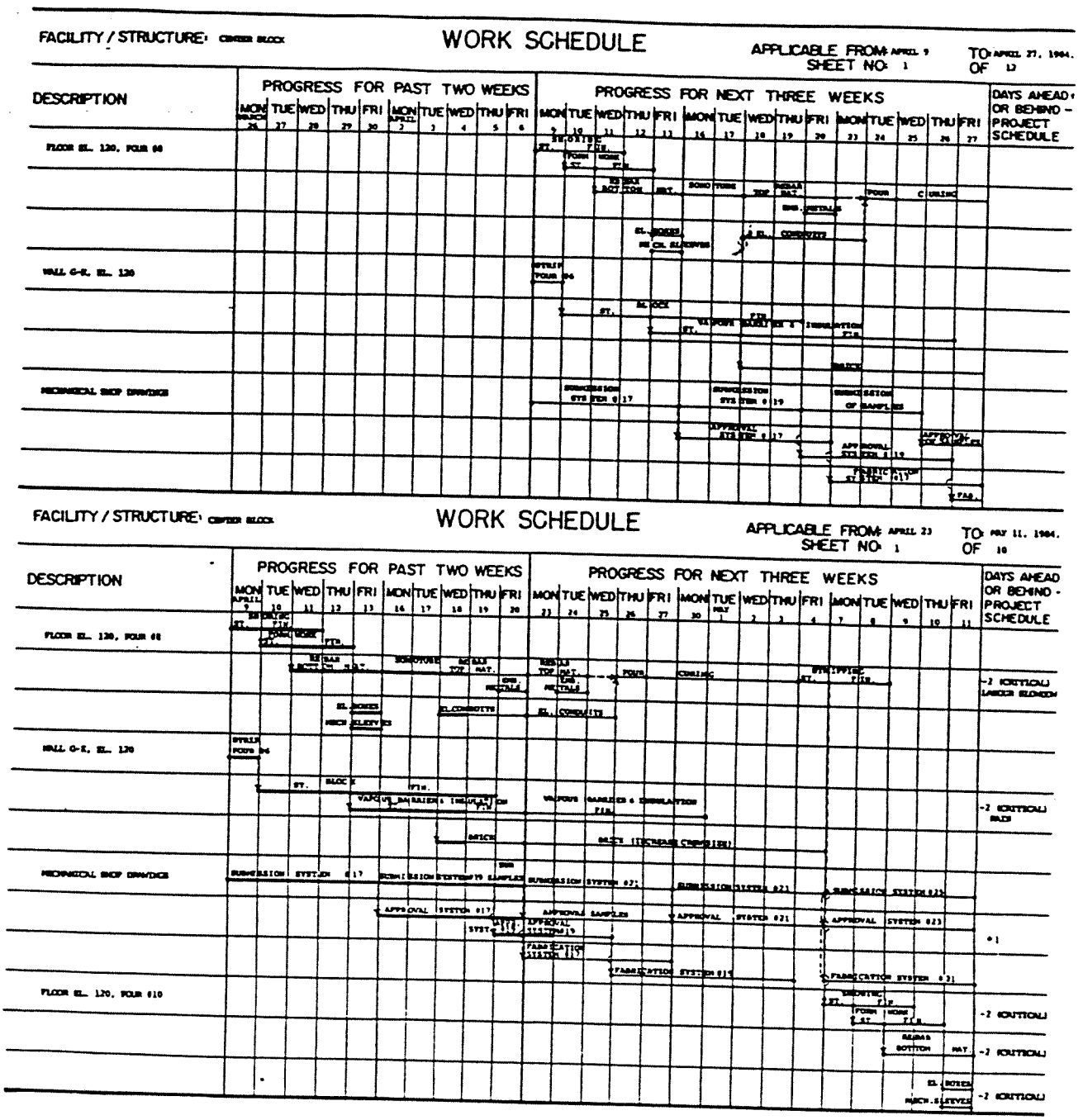


FIGURE 6 SHORT-CYCLE SCHEDULING FORMAT

everybody understands and is enthused by the results, such techniques may even be called by their names, and the objective of improving project management techniques will have been accomplished.

The provincial government's understanding of the uniqueness of the local situation and its guidance in optimizing local resources have been highly successful in improving the local project management scene, an important step towards minimizing claims under the project management concept.

Owner's Pre-Project Experience

The Department of Public Works and Services in the Province of Newfoundland is responsible for implementing construction of the major buildings that are erected for the provincial government. These buildings include hospitals, large adult and post-secondary education facilities, and similar projects.

		A	B	C	D=B+C	E	F	G=E+F	H	I	J=H+I	K	L=G+K	M=D-L	N=M*-M	
		BUDGET				CONTRACT VALUE			ACTUAL COSTS			TOTAL FORECAST COST				
ACCT CODE NO.	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET AGREED BY OWNER APR. 18/84	*OWNER'S REVISIONS	CURRENT BUDGET	ORIGINAL CONTRACT VALUE	CONTRACT CHANGES TO DATE	CURRENT CONTRACT VALUE	PREVIOUSLY APPROVED	APPROVED THIS MONTH	TOTAL APPROVED TO DATE	ESTIMATED COST OF CHANGES TO COMPLETE	FORECAST OF FINAL COST	VARIANCE	VARIANCE CHANGE FROM PREVIOUS REPORT	REMARKS
800	Site Security	90,000	90,000	-	90,000	84,641	-	84,641	53,333	4,318	57,651	5,359	90,000	-	-	
1800	Site Grading	525,000	496,366	-	496,366	419,174	77,192	496,366	496,366	-	496,366	-	496,366	-	-	
2000	Site Services #1	500,000	402,400	-	402,400	403,280	(22,547)	380,733	380,733	-	380,733	-	380,733	21,667		
2200	Services to Site Office	45,000	35,117	-	35,117	34,400	717	35,117	35,117	-	35,117	-	35,117	-	-	
2400	Excavations & Foundations	1,150,000	905,571	-	905,571	929,100	(25,309)	903,791	903,791	-	903,791	-	903,791	1,780	-	
2600	Structural Concrete	2,300,000	2,235,984	15,698	2,251,682	2,190,176	14,631	2,204,807	2,204,807	-	2,204,807	-	2,204,807	46,875	-	
2800	Structural Steel	1,100,000	1,142,768	-	1,142,768	1,129,696	(10,000)	1,119,696	1,109,616	-	1,109,616	7,807	1,127,503	15,265	-	
3000	Mechanical	3,600,000	3,428,800	65,714	3,494,514	3,306,000	94,049	3,400,049	3,146,712	128,219	3,274,931	98,131	3,498,180	(3,666)	18,435	
3200	Electrical	3,120,000	2,832,624	70,553	2,903,177	2,713,400	51,120	2,764,520	2,355,702	109,185	2,464,887	78,432	2,842,952	60,225	9,769	
3400	Sprinkler & Fire Protection	435,000	451,000	920	451,920	454,000	(26,221)	427,779	339,865	51,454	391,319	12,500	440,279	11,641	920	
3600	Architectural	6,210,000	7,970,600	11,866	7,982,466	7,695,748	(133,359)	7,562,389	6,797,556	294,330	7,091,886	189,035	7,751,424	231,042	3,701	
3800	Kitchen Equipment	550,000	550,000	34,913	584,913	508,920	-	508,920	199,123	124,996	324,119	41,080	550,000	34,913	-	
4000	Site Services #2	380,000	400,000	27,767	427,767	373,675	2,850	376,525	328,683	22,701	351,384	23,475	400,000	27,767	-	
4200	Siteworks/ Landscaping	970,000	1,200,000	72,600	1,272,600	1,197,796	-	1,197,796	-	43,718	43,718	74,804	1,272,600	-	-	
4400	Laboratory/Library Furniture	770,000	790,000	-	790,000	814,407	1,931	816,338	423,006	248,737	671,743	21,663	838,001	(48,001)	(774)	
	Contingency	1,087,000	-	-	-	-	-	-	-	-	-	-	-	-	-	
4600	General Conditions	435,000	435,000	-	435,000	435,000	-	435,000	73,138	18,584	91,722	(95,000)	340,000	95,000	73,000	
	Building Permit	-	140,000	-	140,000	140,000	-	140,000	-	-	-	(10,000)	130,000	10,000	10,000	
	TOTALS	23,267,000	23,506,230	300,031	23,806,261	22,829,413	25,054	22,854,467	18,847,548	1,046,242	19,893,790	447,286	23,301,753	504,508	115,051	

FIGURE 7 PROJECT STATUS REPORT

The department has been responsible for the design and construction of facilities up to 640,000 square feet of floor area, and as certain institutions are planned to be integrated, larger and more complex buildings will come under the responsibility of the department. Over the years the department utilized various methods of construction, including the conventional general contracting, the classical project management, and the modified construction management system. Experiences have ranged from very good to very bad on each of the methods chosen.

GENERAL CONTRACTOR CONCEPT

The department generally favors the use of general contractors under the supervision of the project's architect. From the department's point of view, these projects are controlled by senior, in-house project managers whose responsibility is project direction from inception until commissioning, including financial control and scheduling. This method has proven successful for smaller projects up to the size of $15,000,000.

These projects were not built under "fast-track" or "phased-construction" programs, and the entire design was completed before public tenders were called for the complete project. At times separate tenders were called during the planning stage for site preparation to enable the general contractor to move on-site without the uncertainties of clearing, grubbing, and excavation, thus resulting in earlier start of main building construction and lower prices. Under this method some claims had to be dealt with, normally caused by lateness in decision-making on the part of the user-client. Generally, these were delay claims and posed little problems for settlement.

Another minor source of claims arose from certain inaccuracies in drawings or misinterpretation of drawings. Most of these claims were settled out of court to both the contractor's and client's mutual satisfaction.

				O	P	Q	R	K=O+P+Q+R
Accounts Code No.	Description	Current Contract Value	Includes Last CO No.	Approved COs Not Included in Current Contract Value	Estimate of Known Changes	Unidentified Changes to Complete	Allowance for Additional Anticipated Costs	Estimated Cost of Changes to Completion
800	Site Security	84,641	-	-	-	5,359	-	5,359
1800	Site Grading	496,366	1	-	-	-	-	-
2000	Site Services No. 1	380,733	4	-	-	-	-	-
2200	Services to Site Office	35,117	1	-	-	-	-	-
2400	Excavations & Foundations	903,791	7	-	-	-	-	-
2600	Structural Concrete	2,204,807	6	-	-	-	-	-
2800	Structural Steel	1,119,696	1	-	7,807	-	-	7,807
3000	Mechanical	3,400,049	29	-	53,131	45,000	-	98,131
3200	Electrical	2,764,520	18	-	8,432	70,000	-	78,432
3400	Sprinkler s & Fire Protection	427,779	3	-	500	12,000	-	12,500
3600	Architectural	7,562,389	51	-	121,035	68,000	-	189,035
3800	Kitchen Equipment	508,920	-	-	-	41,080	-	41,080
4000	Site Services No. 1	326,525	2			23,475		23,475
4200	Paving, Landscaping & Site Lighting	1,197,796	-	-	-	74,804	-	74,804
4400	Wood/Metal Cabinetwork & Specialties	816,338	4	-	21,663	-	-	21,663
4600	General Conditions	436,000	-	-	(95,000)	-	-	(95,000)
	Building Permit	140,000	-	-	(10,000)	-	-	(10,000)
	TOTALS	22,854,467		-	107,568	339,718	-	447,286

FIGURE 8 SUBSIDIARY COST REPORT

PROJECT MANAGEMENT CONCEPT

The department, on larger and more complex projects, has utilized the project management method of construction. However, recent experience with this method has yielded lengthy delays, high cost overruns, and large claims, caused by a certain over-enthusiasm and overoptimism by project managers.

Moreover, the conclusion derived from a study of these projects was that 1) the risks of fast-tracking were far too great and unpredictable, and 2) "phased construction" was the alternative to minimize those risks.

"FAST-TRACK" VERSUS "PHASED CONSTRUCTION"

Project managers, as well as literature on the subject, all too often refer to the terms "phased construction" and "fast-track" interchangeably, without any distinction. Although similar in some respects, the two methods differ in the type of design/construction overlap. The design of an individual work package in "phased construction" is substantially complete when construction starts. With "fast-tracking," work packages are rushed to the field, with the design being completed after construction has begun. In short, fast-tracking is an accelerated "phased construction" method with design/construction overlap within the individual work packages.

The two methods only resemble each other to the extent that construction starts before the entire project design is 100 percent complete. The analysis of fast-tracking projects indicates that inherent risks include:

- loss of the planned benefits due to schedule delays

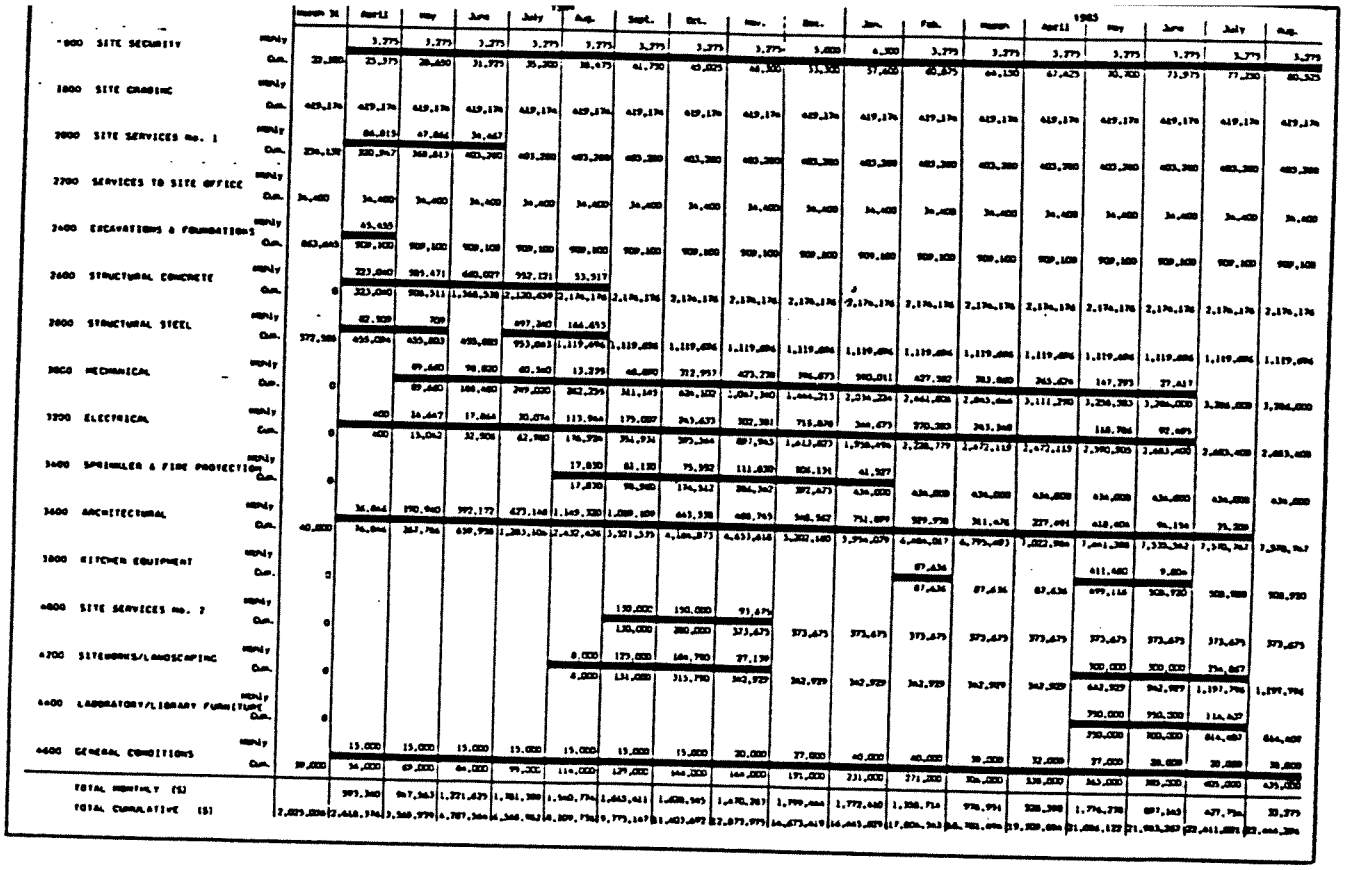


FIGURE 9 BUDGET CURVE DATA—ORIGINAL CONTRACT

- loss of financial benefits due to the cost of claims and litigation
- intentionally low bids and unrealistic schedules by contractors because of incomplete tender specifications, resulting in artificially high pricing of extra work and change orders as well as claims
- far-reaching effects of mistakes during the early design/engineering phase.

Evolution of a Modified Concept

With regard to the Institute of Fisheries, the department carefully evaluated its options. Because of the size of the project ($42.3 million), the complexity and the user-client's early occupancy requirements, the department decided to use the project management concept.

However, because of the recent negative results with respect to delays, cost overruns, and claim situations, the traditional concept was modified through the introduction of an independent auditing/quantity surveying consultant with responsibility for preparation of detailed contractor-type construction estimates, master scheduling, and for monitoring of project expenditures and financial/schedule projections.

Rationale

The rationale for the introduction of this new team player was based on the fact that historically project/construction managers, with respect to schedule and budget, tend to lean toward either one of two extreme directions:

- PM/CM creates an extremely tight budget and schedule to secure approval of the project and/or mandate.

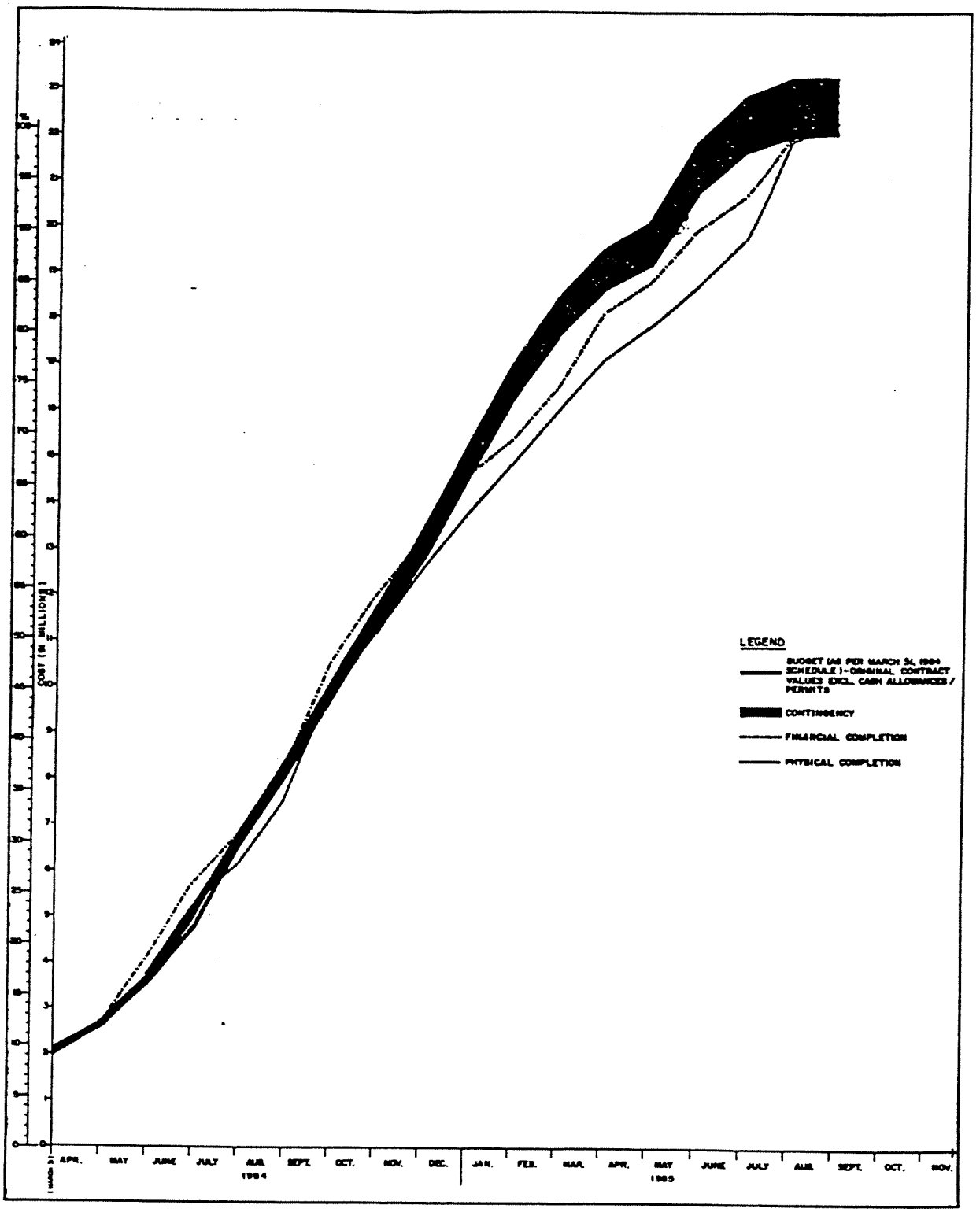


FIGURE 10 PERFORMANCE TEST—TOTAL PROJECT

• PM/CM creates an unnecessarily high budget and extended project duration to minimize his liabilities towards the owner.

The department concluded that the introduction of an independent third party will circumvent those desires which are understandable and human, but seldom justified.

While the tasks of scheduling, estimating, and monitoring are traditionally carried out by the PM/CM, the independent third party can perform the same tasks without any conflict of interest.

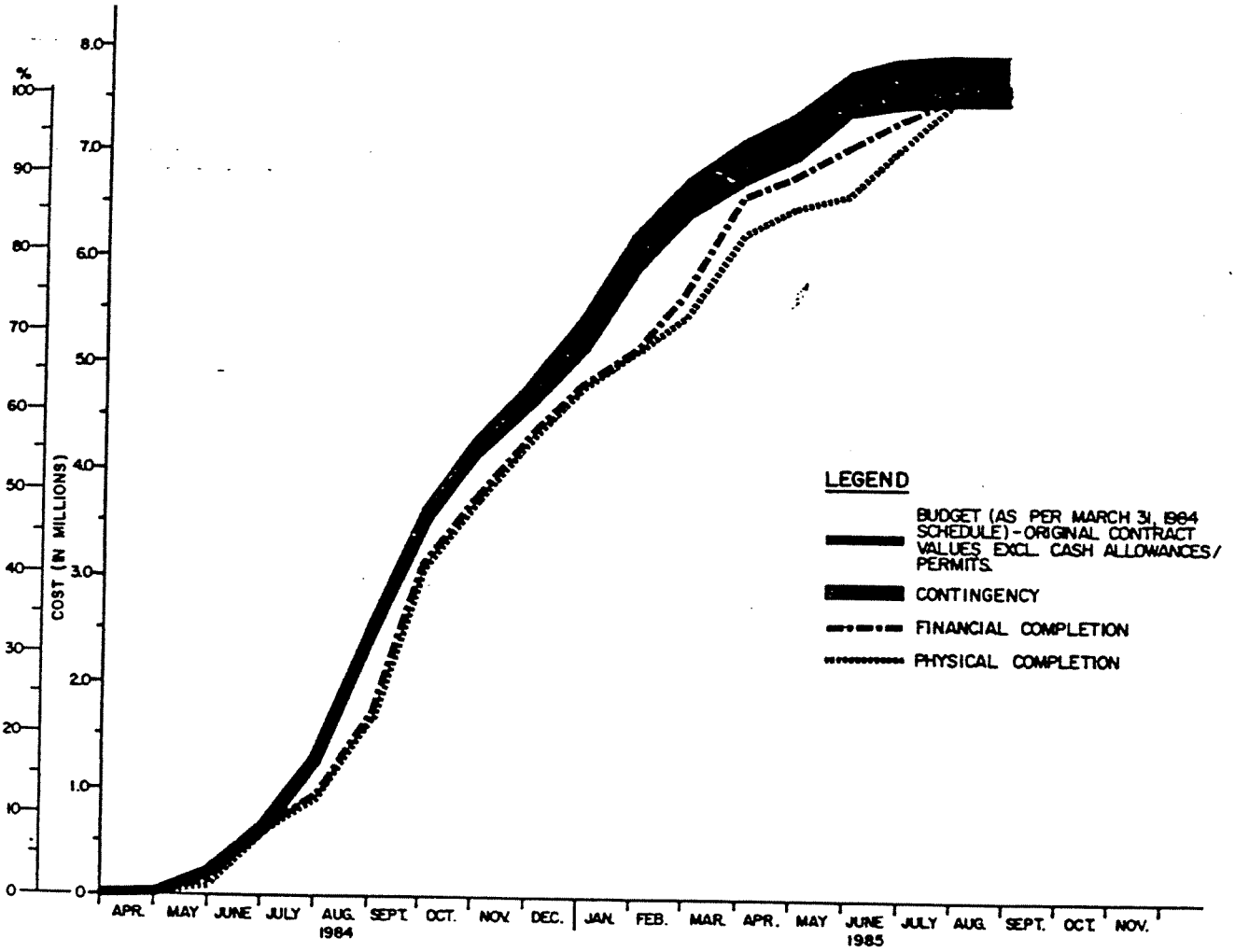
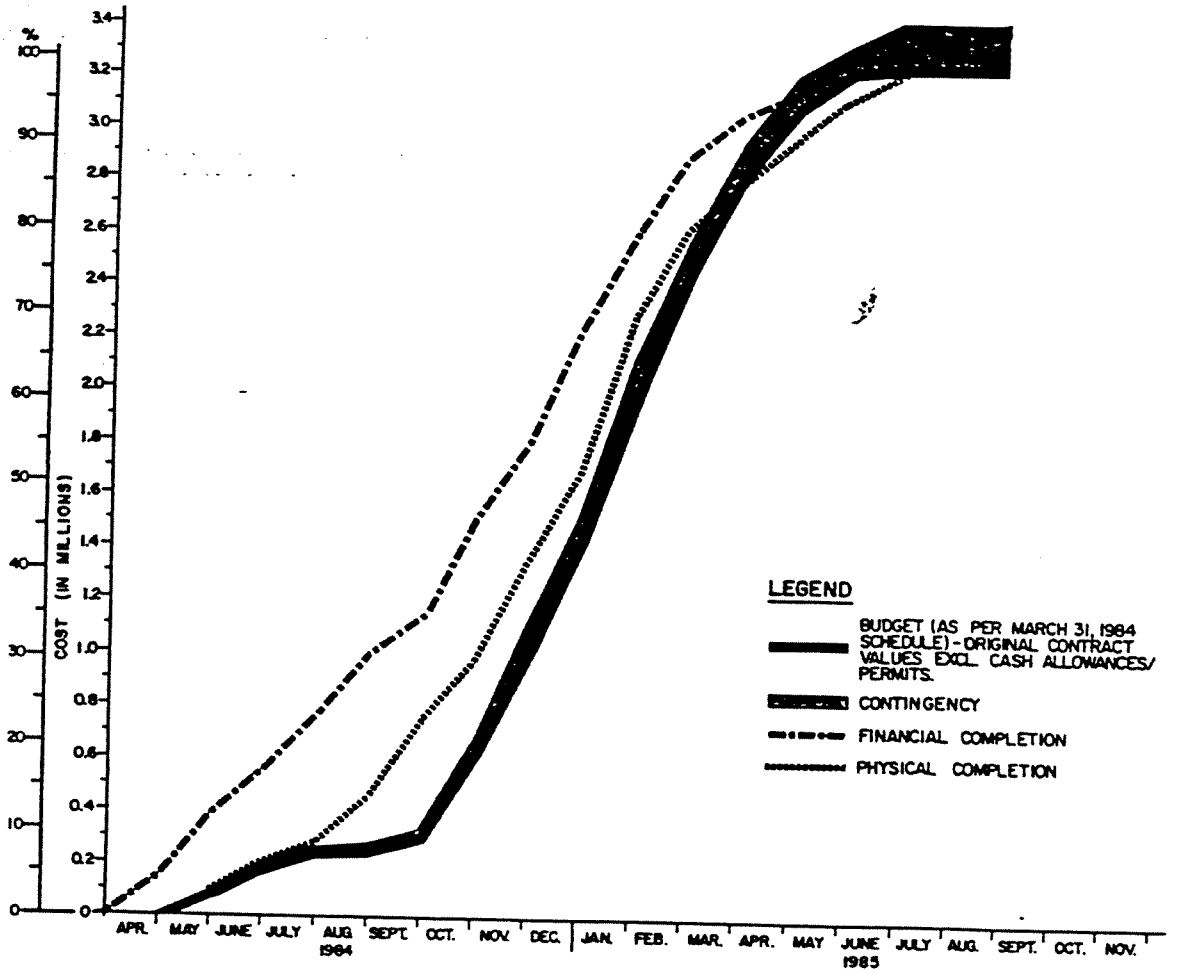


FIGURE 11 PERFORMANCE TEST—ARCHITECTURAL PACKAGE

In light of most recent court decisions in the United States, the importance of unbiased monitoring by a party without any financial interest, ensuring quick reaction time, is even more significant. In the eyes of the law, the scheduling and coordinating responsibilities under the project management concept rest with the owner in her capacity as the principal of her agent, the PM/CM. In the past, owners have tried to escape this risk by making prime contractors responsible for coordination, but with little success, as courts consider such responsibility unenforceable (i.e., prime contractor "A" has absolutely no means to force prime contractor "B" to do anything he would not do voluntarily). This was stated very clearly by the GSA Board of Contract Appeals in the case of Jacobson & Co., GS BSA No. 5606, 80-2 BCA (CCH) 1980.

> The Government can decide on whatever method of construction and contracting it chooses, but in doing so it also assumes the responsibilities inherent in its choice. With phased construction, it is obvious that the contracting officer has the obligation and duty to demand that the various contractors cooperate with the construction schedule and not interfere with the work of other contractors.



GURE 12 PERFORMANCE TEST—MECHANICAL PACKAGE

While the owner may always have legal recourse against the PM/CM, responsibility for payment of a justified prime contractor's claim resulting from the action, neglect, or delay on the part of his agent (i.e., PM/CM) rests in first instance with the owner.

It is evident that preventive measures are less costly than lengthy legal battles extending years beyond project completion.

The New Project Team

The department, in order of priority, appointed a project manager, prime consultant (design), and an auditing/quantity surveyor consultant. The organizational structure was such that the prime consultant reported to the project manager, whereas the auditing/quantity surveying consultant reported independently to the department to ensure that objectivity was maintained, and that it would not become overly familiar with the needs of the construction and design groups.

The department, through past experience, had learned the vital importance of ensuring that all participants had clear definitions of their responsibilities and the roles they were to play on the project. The department further insisted that detailed administrative procedures with regard to equipment procurement, progress payments, change orders, and so on be drawn up and in place before the start of construction to ensure that there would be no misinterpretation or misunderstanding of what had to be done by each member of the project team.

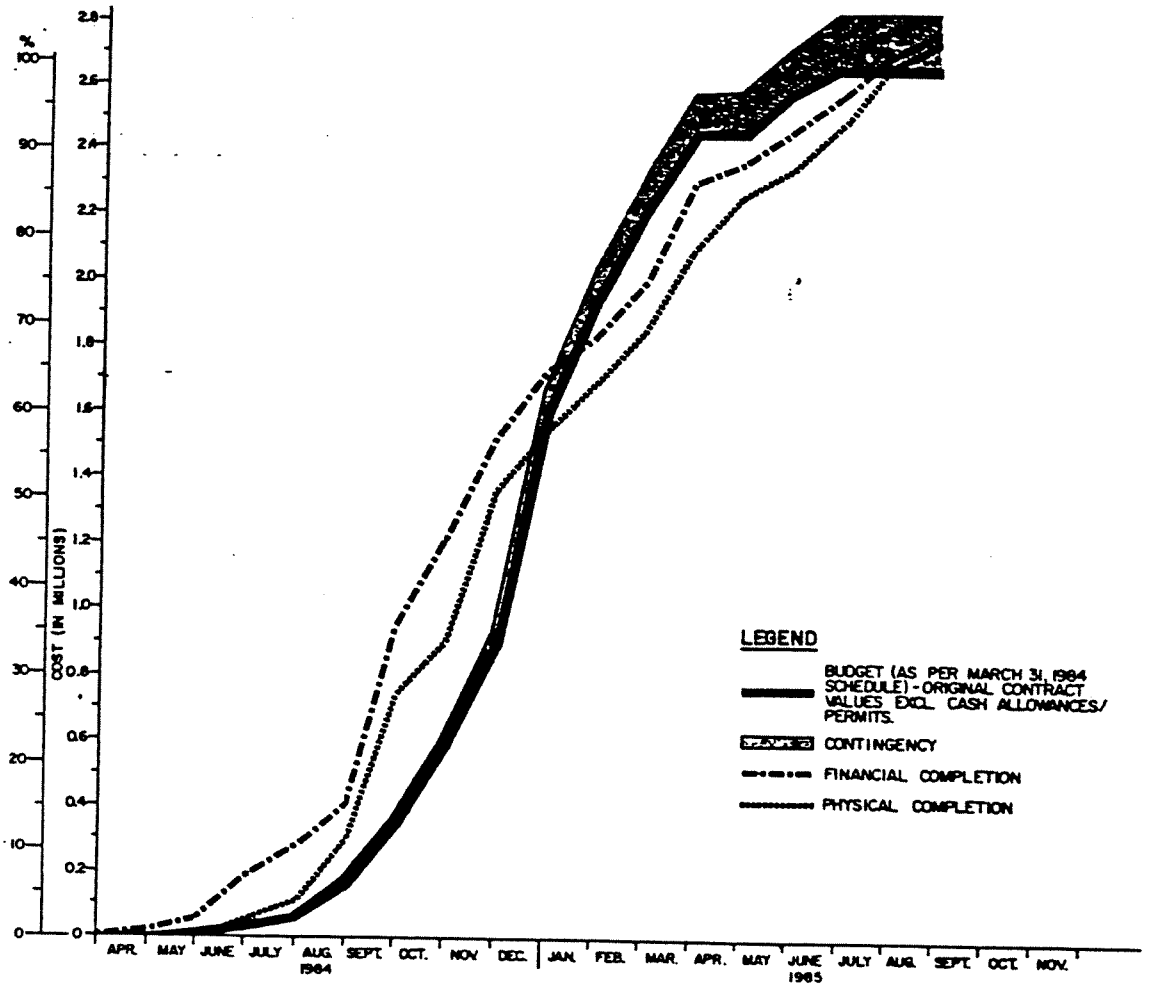


FIGURE 13 PERFORMANCE TEST—ELECTRICAL PACKAGE

There was some initial concern on the part of the project manager that such detailed procedures were too onerous and would slow down the project, but subsequent advantages voided that concern.

The Project Manager

The firm chosen to perform the functions of project manager was a local firm specializing in this field and was planning to do its own construction management. The senior representatives designated to be responsible for the execution of this project had either a strong background in design or in general contracting in the Newfoundland environment. The project manager reported to the owner on a monthly basis on tendering, costs, on-site construction activities, and scheduling, as well as problems and key activities. The initial reaction to the introduction of an additional consultant was not overly enthusiastic and governed by a typical reaction to anything new: "We've always gotten by before; why should this time be any different?"

The Prime Consultant

The design firm chosen by the owner was a major local architectural/engineering firm with experience in working under the project management concept. This firm reported to the project manager. An offshore firm assisted in the preparation of the mechanical and electrical design.

Total Project		
Budget	74.1 %	73.8%*
Financial Completion	69.6%	70.3%*
Physical Completion	66.8%	67.4%*
Architectural Package		
Budget	78.6%	
Financial Completion	67.7 %	
Physical Completion	67.7 %	
Electrical Package		
Budget	73.0%	
Financial Completion	68.1%	
Physical Completion	61.8%	
Mechanical Package		
Budget	61.9%	
Financial Completion	78.9%	
Physical Completion	68.5%	

*Corrected for current savings of $210,000 in General Conditions.

FIGURE 14 STATUS OF COMPLETION—JAN. 31, 1985

The Auditing/Quantity Surveying Consultant

The newcomer to the traditional project management concept, selected from several invited bidders, was made up of:

- the local branch of a major international audit/management consulting firm (assisted by its in-house, mainland management experts)
- a mainland construction management consulting firm specializing in estimating, planning, and cost control, as well as preparation and/or evaluation of construction claims.

Throughout this paper, the auditing/quantity surveying consultant will be referred to as the "consultant."

Scope of the Consultant's Mandate

Following several discussions with the owner, the mandate of this consultant was agreed upon to include:

Start-Up Phase

- setting-up of code of accounts
- assistance in the preparation of administrative procedures
- preparation of independent detailed contractor-type estimate in addition to estimates prepared by project manager and prime consultant
- preparation of realistic master schedule for design, procurement, and construction, in collaboration with project/construction manager
- design of cost and change order control system, in collaboration with project/construction manager.

Monitoring Phase

- monthly audit of expenditures to date, as well as projection of the final costs
- independent reporting on progress
- design and subsequent application of performance test (quantity surveying system) to advise owner of status of progress versus expenditures, and to

serve as an early warning system to either prevent or minimize claims or detect potential claims early

- report to department on regular intervals and meet with project team on the construction site.

The consultant was officially appointed in late summer 1983, when site clearing had been completed and design was approximately 60 percent complete, tenders for the packages "excavation and foundation" and "site services no. 1" were about to be received, and tenders for the structural steel package was to be called shortly. However, above-grade site construction was not to start before spring 1984.

Start-Up Phase

Preparation of the independent detailed contractor-type estimate and master schedule commenced immediately after a familiarization meeting with all members of the project team, receipt of master schedule in force (bar chart), and drawings and specifications available at that time.

Within two weeks, the preliminary evaluation of the available information had advanced to the point when certain important questions required clarification. The most important and pressing question to be dealt with was the completion date of the project.

Completion of the project was scheduled for spring 1986 with the complex relocation of existing equipment, furniture, etc., to take place during the summer months, all to be completed prior to the September start of the 1986/87 academic year.

From its preliminary analysis, the consultant concluded that the project could be completed about ten months earlier than planned, barring a possible construction strike in May 1985, when all current labor agreements were to expire.

Thus, the following two questions were asked:

- Is the spring 1986 completion date the result of budgetary/cash-flow constraints imposed by the Federal/Provincial Funding Agreement?
- Is the college physically able to move one year earlier?

Additionally, the preliminary status of the tender package breakdown, as well as the wisdom of calling any further tenders in the absence of an approved master schedule, were questioned. More specifically, the consultant cautioned the inclusion of any vague dates in the tender documents as long as there was no approved master schedule, thereby making specific reference to contractual clause 1.2 in the structural steel contract package (out for tender at this time), which reads, in part:

> .4 Caution—The owner will not be responsible for any delay claim resulting from late completion of structural concrete work, or other circumstances, which prevent start-up by these target dates.

In clear terms, the consultant stated at this point, in writing:

> Exculpatory clauses such as 1.2.4 should not be used as an excuse for the absence of an agreed-upon schedule.

The owner's reply with regard to the 1986 completion date clarified that none of the reasons suspected applied. Nevertheless, it was the owner who had advised the project manager that under the project management concept

it had seen too many forecasted completion dates which, in fact, could not be met, all resulting in ramifications much worse than a realistic completion date at the outset of the project. The owner, however, fully agreed that:

- an early decision with regard to the tender package breakdown was essential
- no further tenders were to be called without an approved master schedule
- the use of contractual exculpatory clauses was no answer to a self-inflicted avoidable claim situation.

This first quick exchange of correspondence, copies of which were transmitted to the PM/CM, resulted in a three-day working session on-site between the consultant and PM/CM, in part also attended by the prime consultant.

Concerning the completion date, the entire team agreed that construction could be substantially completed by summer 1985, and with an earnest effort by all parties, the college could be opened in September 1985.

The tender packages breakdown was agreed upon, with the exception of architectural work which remained to be resolved at a later date.

The tender call for the structural concrete was to be issued in late November 1983, with mechanical, electrical, and fire protection packages to follow around mid-December 1983.

Admittedly, the road was bumpy in the beginning, but smoothed out once it was established that the objectives of the outside consultant were no different from those of the PM/CM, namely, to successfully complete the project within budget and on time.

The Construction Cost Estimate

The preparation of a detailed contractor-type estimate normally requires drawings and specifications that are reasonably complete (i.e., 85 percent to 90 percent).

In the fall of 1983, the drawings and specifications were at varying stages of completion ranging from practically nil to 100 percent (structural steel package out for tender). With regard to architectural work, it was found that there were many conflicts between drawings and finishing schedules. All conflicts were immediately reported to the prime consultant. Certain specifications were obtained verbally; others were not available yet. While preparing the estimate, drawings were continuously revised, and corresponding adjustments had to be made to the estimate, and every attempt was made to incorporate the intent of the design into the estimate. The consultant's estimating team relied heavily on one of its member's specific knowledge of Newfoundland conditions which, being a native Newfoundlander, had gained from his fifteen years of contracting experience in Newfoundland.

The consultant, in the preparation of the estimate, went far beyond the standard contractor's approach.

The consultant first established a common work breakdown structure for estimate and master schedule activities, which would later facilitate the cost loading of the master schedule designed to serve as the basis for monitoring progress and expenditures.

1. The difference between financial and physical completion, i.e., $1,6222,483, is the estimated amount paid for materials delivered to site but not installed yet. Approximately 50% of this amount is related to the Mechanical Contract, approximately 25% to the Electrical Contract, and the remaining 25% to the Sprinkler and Fire Protection, Kitchen Equipment Laboratory/Library Furniture and Site Services No. 2 combined.

2. The negative status of physical completion versus budget, i.e., -7.3%, is made up of a combination of several factors, as follows:

a)	Savings in General Conditions	-1.0 %
b)	Postponement of Site Works/ Landscaping Contract	-1.7 %
c)	Delay in Site Services No. 2 Contract	-0.2 %
d)	Delay in Architectural Contract	-3.7 %
e)	Delay in Electrical Contract	-1.2 %
f)	Delay in Sprinkler Contract	-1.1 %
g)	Advance in Mechanical Contract	+1.0 %
h)	Extra Work Performed	+0.5 %

   The combined shortfall of the Architectural, Electrical, and Sprinkler Contracts amounts to a substantial 6%, or $1.3 million. Moreover, progress recorded on the Sprinkler Contract is either too optimistic, or Contractor was underpaid.

3. The budget projection of Jan. 31, 1985, included $580,000 for contingencies allocated to the individual contract packages. Approximately 28% are expended to date. Additionally, out of the $231,000 allocated to General Conditions, only $20,724 were actually expended. However, permanent heating commenced on Jan. 25, 1985, and monthly expenditures will increase accordingly.

4. The Architectural package, and more specifically, installation of drywall and ceilings, have seriously fallen behind schedule, resulting in a corresponding delay on electrical work. Low performance was further aggravated by the non-availability of permanent heating until Jan. 25, 1985, and the delay in enclosure of the atrium. Progress of drywall and ceiling installations is now improving in the east block and west block, while the center block is still slowed down because of the atrium.

   Notwithstanding this improvement, the completion date will be extended by one month, i.e., to early September 1985, without implementation of an acceleration program. Nevertheless, it is anticipated that the project will be completed within budget.

GURE 15 CONCLUSIONS—JAN. 31, 1985 PERFORMANCE TEST

The Master Schedule

The master schedule, although prepared by the consultant, nevertheless clearly reflected the intents of the PM/CM, who was ultimately responsible for the supervision and coordination of the work.

The initial run resulted in a September 1985 completion date. Subsequent compression of the interior finishing yielded the desired early August 1985 completion date. The latter schedule was to serve as a yardstick for all future evaluations of performance.

In order to achieve the accelerated completion date, the consultant recommended that detailed schedules for the interfacing of the electrical, mechanical, fire protection, interior masonry, and drywall trades be prepared, to avoid claims which often arise from lack of coordination between these trades. To counteract these problems, it was further recommended that interference drawings be prepared by the mechanical contractor. For the purpose of the detailed scheduling, the consultant supplied the CM with an easy-to-follow format for short-cycle scheduling.

The Cost and Change Order Control System

The cost reporting and change order control system designed for this project include the following:

- cost summary
- project status report
- subsidiary cost report
- contract assessment for each contract package
- monthly cash-flow comparison.

The monthly cost summary and cash-flow comparison included expenditures for the entire project, while the other three reports included construction costs only.

The project status report was developed as an executive summary, providing all information on budget, contract value, actual costs, total forecasted cost, and variances. The main headings were subdivided as follows:

Budget:	Original budget (PM/CM)
	Revised budget
	Owner's revisions (scope changes)
	Current budget
Contract value:	Original contract value
	Changes to date
	Current contract value
Actual costs:	Previously approved
	Approved this month
	Total approved to date
Forecasted costs:	Estimated cost of changes to complete
	Forecast of final cost
Variance:	Total variance
	Variance change from previous report

The column "Revised Budget" was introduced in April 1984 as a result of the tenders received for the architectural package, which were substantially higher than the PM's original budget. At the same time, the general contingency carried in the estimate was allocated to the individual work

packages to reflect the cost of anticipated changes to the work, as well as anticipated costs of acceleration to meet the critical completion date.

The column "Owner's Revisions" reflected change orders originating from owner's scope changes. These were kept separate, since the PM/CM carried no responsibility for these changes. Hence, they had to be excluded for measuring his performance.

For the purpose of "controlling costs," the most important column of the project status report is found under the heading "Estimated Cost of Changes to Complete." The consultant insisted that the CM was to identify monthly for each contract package what kind of additional costs it expected to incur until completion of the work. A subsidiary cost report was designed to separate:

- changes approved and included in current contract value, indicating the last change included
- change orders approved by CM but not approved by owner
- estimate of known changes
- unidentified changes to complete
- allowance for additional anticipated costs.

The introduction of this level of detail forced the PM/CM and the prime consultant to analyze, explain, and justify monthly forthcoming changes and issue them in a timely manner, so as not to interfere with the progress of the work which otherwise could result in claims for delays and/or loss of productivity.

Additional reasons for this monthly justification of estimated cost of changes to complete were:

- to seek remedial action if the final cost was forecasted to exceed the budget
- to free unused monies for allocation to other items such as owner's budget for new equipment, furniture, etc., which otherwise could not be purchased.

Monitoring Phase

A performance test was designed with the objective of accurately measuring progress and expenditures against budget and master schedule and to immediately signal problems which may jeopardize completion within time and budget. At the same time, this test, coupled with the cost reporting system, was to serve as an early warning system for discovery of potential claim situations which, if known at the incipient stage, could effectively be minimized or remedied. It is evident that for this purpose, time and cost have to be measured on an integrated basis, a concept not always understood and/or applied.

The performance test measures financial and physical completion of the project at any given stage against the budget as follows:

- Physical completion is the value of work accomplished and expressed as a percentage of the estimated value as of the date the analysis is prepared.
- Financial completion is the total amount of money spent (or committed) as of the date of the analysis, expressed as a percentage of the total estimated cost.
- The budget curve reflects the progress as depicted on the master schedule and corresponding expenditures thereof, or in other words, it indicates the earned percentage of the elapsed time of the project.

A detailed S-curve was prepared based on the cost-loaded master schedule and the estimate, adjusted for actual tender prices, received. The common work breakdown structure established for the construction cost estimate and the master schedule facilitated this task. Particular attention was paid to the labor/material breakdown of each activity, since material on-site, but not installed, was not considered progress. Time-oriented activities only—such as labor, approvals, lead-time for deliveries—were to be considered for the determination of physical completion.

A second budget curve was established which included contingencies allocated to each contract package within the timeframe they were most likely to be incurred.

Budget curves were translated into graphics for the entire project, as well as for the electrical, mechanical, and architectural packages. The reason for also controlling these three packages on an individual basis was based on the fact that the majority of building construction claims originate from one of these trades because of the close coordination required between them.

Application of Performance Test

The 75 percent completion stage has been selected for a demonstration of the application of the performance test.

Conclusions

The owner's choice of the "phased construction" method, coupled with the modified project management concept whereby an independent third party without any direct financial involvement was added to the traditional project team, undoubtedly were the two key factors responsible for the successful completion of this project.

The third party preparation of a contractor-type construction cost estimate and the master schedule, both based on a common work breakdown structure, allowed for the design of an accurate performance test/early warning system. Simplicity of presentation instead of voluminous computer printouts resulted in usage rather than storage in drawers.

This system, combined with the independence of the consultant, allowed for totally objective and timely evaluation of progress and cost. The latter facility, in turn, assured early reaction time. Independence proved equally successful for:

- the unbiased adjudication of scope changes
- constructive communications between all parties
- acceleration of reaction time on all aspects of the project, notwithstanding time-consuming governmental procedures.

Hence, claims were not only minimized but, in fact, completely avoided. A word of caution, however: only "man-made" claims are controllable. Extended project durations and corresponding increases in cost cannot be prevented in case of strikes, changed soil conditions, or similar "non-man-made" causes. However, in any claim situation, early reaction time and an unbiased adjudication process will reduce the cost of claims.

Minimizing Construction Claims Under the Project Management Concept

1. What are some of the key management skills needed to run a project or enterprise? Support your answers with information from the *PMBOK Guide*.

2. What problems were encountered under the project management concept in this case?

3. Describe the "risky" practice that was leading to some of these problems, including some of the overriding factors that negated any projected benefits.

4. Describe the modified project management approach used to reduce some of these risks.

5. What risks was the Department of Public Works and Services trying to reduce by adding another consultant to the project management team?

6. What were some of the contributions made by the auditing/quantity surveying consultant? How did these contributions minimize project risk?

7. What actions can be taken by project managers to minimize some of the associated risks before starting to monitor a project?