Project management on a reimbursable, plus-fee contract*

by F. VAN HEERDEN†, M.S.A.I.C.E., M.S.A.I.M.M.

SYNOPSIS

The paper sketches the management of the various phases in a cost-reimbursable, plus-fee contract, which is claimed to be the most flexible of all contracts. In this type of contract, the contractor is reimbursed for all the direct costs incurred, plus a percentage fee to cover his profit (or overheads and profit). The client usually reserves the right to approve all drawings, equipment purchases, contract awards, technical specifications, project cheques, and change orders.

SAMEVATTING

Die referaat skets die bestuur van die verskillende fases in 'n kontrak waar die koste plus 'n vergoeding betaal word, wat na bewering die buigsaamste kontrak is. In hierdie tipe kontrak word die kontrakteur vergoed vir al die regstreekse koste wat aangegaan word, plus 'n persentasie vergoeding om sy wins (of bokoste en wins) te dek. Die kliënt behou gewoonlik die reg voor om alle tekeninge, aankope van toerusting, toekennings van kontrakte, tegniese spesifikasies, projektjeks en variasieorders goed te keur.

Introduction

The need for effective project control is now greater than ever. Metallurgical projects have been getting bigger and more complex, requiring expenditures of millions of rands by clients who have limited project resources.

Cost control is the all-important concern of project management. It is vital to protect a project against risks of poor performance or default by any of the participating parties. These include the client's own engineers, and the contractors, sub-contractors, suppliers, and others. The major risks are cost overruns, delays, and poor workmanship in any of the major stages of the project: concept, design, fabrication, construction, and start-up.

What exactly constitutes a successful project depends on whether it is considered from the point of view of the owner or of the contractor.

From the owner's point of view a project can be considered to be successful if it satisfied the following basic criteria:

- the work is completed on or before the agreed schedule date,
- it is completed within the budget allocated,
- it is completed without untoward events,
- it fulfils the purpose for which it was built.

The principal criteria for satisfaction on the part of the contractor involve the following:

- the customer must be satisfied (i.e. the owner's criteria as listed above must be met),
- the contractor must make an appropriate profit,
- the contractor's resources must have been employed in the planned way.

A truly successful project will leave both owner and contractor satisfied. Sometimes both parties end up wholly dissatisfied. Between these two extremes there are many degrees of partial achievement.

Some aspects by which failure can be avoided by the project manager are now examined.

Cost–reimbursable, Plus–fee Contract

The cost-reimbursable, plus-fee contract is the most flexible of all contract types. The contractor is reimbursed for all the direct costs incurred, plus a percentage fee to cover his profit (or overheads and profit). Under the terms of a cost-plus contract, the client can exercise the option to retain complete control over all aspects of the project execution. He usually reserves the right to approve all drawings, equipment purchases, contract awards, technical specifications, project cheques, and change orders.

Cost-plus contracts are usually criticized on the grounds that the contractor has little incentive to control costs, since his fee is proportional to the total cost of the project. This criticism is true only when insufficient control is exercised over the contractor. In most cases, the client is well represented, maintains close control over the contract expenditure, and has access to the contractor's records. Under this form of contract, the contractor acts as an extension of the client's team, and an essential feature is mutual trust and good faith.

Main advantages

(1) It eliminates costly extra negotiation if many changes are contemplated.
(2) It allows the client flexibility in participating in and supervising the design, construction, and cost control.

Main disadvantages

(1) The client must exercise tight control over the project expenditures.
(2) The project cost is usually not optimized.

Typical application

(1) The existing facilities have to be revamped.
(2) A feasibility study and development projects are

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† Edward L. Bateman Limited, P.O. Box 126, Durban 4000.

required where the scope is not well defined.

(3) The minimum time schedule is critical.

Interfaces

The project manager must be aware of the various interfaces he will have to deal with, and must be prepared to adapt his methods to achieve the end results. Some of the more important contacts are listed below

Client	The people concerned may be managers, engineers, accountants, contracts officer, plant operating personnel, staff at various services departments.
Equipment suppliers	These are varied depending upon the type of plant; it is essential to ensure well-defined scope of work and standards, methods of payment, documentation requirements, escalation formulae, guarantees, commissioning involvement.
Construction contractors	Well-defined contract conditions, scope of work, drawing issues programme, methods of handling claims, dayworks, backcharges, methods of measurement and payment are essential.
Quantity surveyors	Well-defined scope of work, timing of reports, issuing of final certificates, and method of handling claims are important.
Government authorities	Typical contacts are inspector of machinery, and staff in Bantu affairs departments.
Escom and Rand Water Board	Early contact and recognition of these requirements is important as a lead time of two years may be required, as well as regular expediting.

Organization

Usually, the Project Manager will be the prime mover in the arrangement of the project organization, which never remains static owing to the shifting emphasis from concept, design procurement, and construction to commissioning, as well as resignations, promotions, personality clashes, and specific project problems such as fabricator problems.

Ultimately, the organization will operate around the strengths and weaknesses of the individuals in the team, and the project manager will attempt to harness and direct the strengths of the stronger members and supplement the weaknesses of the weaker members, as well as constantly developing a team spirit to keep the team motivated to give of their best despite problems and personal differences.

Control

Control can be defined as the work a manager performs to assess and regulate the work in progress and completed.

The manager is kept informed by reporting; he must ensure that the system of control and reporting enables him to evaluate the problem and take corrective action when necessary.

Costs

The first step in cost control is the preparation of a good estimate. Costs cannot be controlled if the estimate is inadequate, incomplete, or unrealistic. The coded budget then developed is the standard against which all the expenditure is measured. Project costs must be reported under a code of accounts that matches the budget to ensure feedback for comparison.

To cover errors and omissions in the estimate, it is normal to allow a contingency. The movement of funds into and out of this allocation should be with the approval of the project manager. It is also normal to make allowance for escalation. The movement of funds from this allocation should be only for escalation.

Over-running the agreed budget is one of the most common failures, and one that always brands the project

TABLE I

COST AND COMMITMENT REPORT — Report date: Page of

Area code	Description	Budget	Project Value: App'd Change ECO	Project Value: App'd Change CCO	Revised budget	Forecast	Commitments and costs: Committed to date	Commitments and costs: Cost to date	Commitments and costs: Cost this month	Remarks
30		14 080 628	545 515	402 924	15 029 067	16 088 492	18 022 367	16 910 313	2 404 297	
40		1 186 057	82 230	11 519	1 279 066	1 204 630	1 180 424	874 078	84 516	
50		720 836	25 670	10 388	756 834	763 420	723 026	597 324	33 598	
83		1 941 970	1 950	9 250	1 953 170	1 672 345	1 817 086	1 616 601	43 873	
	Total: Direct field costs	17 929 491	655 385	434 083	19 018 937	21 928 867	21 742 903	20 058 399	2 569 289	
	01 Management	296 875	1 442		298 317	430 000	430 008	333 693	13 970	
	02 Procurement	179 662	1 050		177 712	206 777	206 777	211 470	10 496	
	03 Engineering	1 627 809	92 694		1 620 503	2 258 695	2 258 695	2 091 212	9 446	
	04 Site management	365 478	20 678		386 156	769 706	769 706	783 432	116 088	
	Total: Management	2 366 824	118 864		2 482 688	3 665 186	3 665 186	3 479 807	150 000	
	Common distributables	390 772	3 171	55 234	449 177	264 680	233 822	203 257	17 018	
	Total: A+B+C	20 687 087	774 400	489 315	21 950 802	25 858 753	25 641 911	23 886 463	2 733 307	
	Fee, % of D	966 303	40 505	28 136	1 034 953	1 486 878	1 474 410	1 135 228	64 204	
	PROJECT TOTAL	21 653 395	814 908	517 451	22 985 755	27 345 631	27 116 321	24 821 691	2 797 511	
	Escalation	2 855 300	92 704		2 948 001	534 912	1 076 700	575 617	35 830	
	Contingency	1 040 007	33 767		1 073 767	395 671				
	TOTAL: Esc. + Cont.	3 895 300	126 471	—	4 021 771					
	PROJECT VALUE: E+F	25 548 685	941 380	517 451	2 700 752					

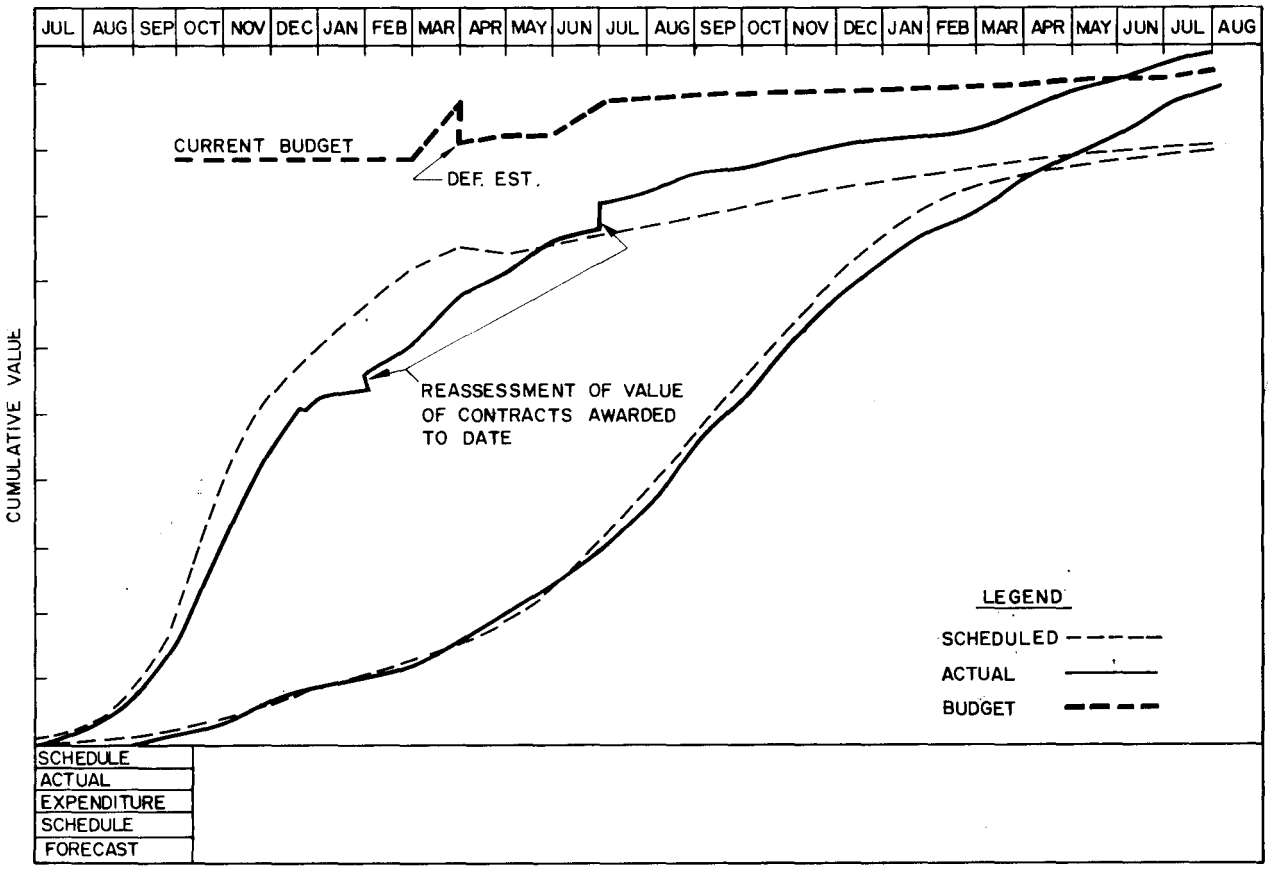


Fig. 1—Total cumulative commitment and expenditure, excluding escalation and contingency but including sales tax

as not completely successful. Cost overruns can be attributed to some of the following reasons.

- The initial estimate was low owing to poor estimating or poor scope definition, or a combination of the two.
- The project as completed varied significantly in scope from the original and was never updated.

It is vital for control to have a rigid system for handling changes and obtaining client approval before commitment to third parties. Table I gives a fictitious example of a cost and commitment report to illustrate a typical report form.

The flow of cash on the project should be monitored in at least two categories: committed and expended costs together with forecasts (Fig. 1).

Resources

The major project variable under the control of the management contractor is the management resources. This is easily controlled by plotting actual expenditure against budget, and making monthly forecasts of requirements to complete, adding any scope changes. It is useful to plot man-hours and costs since certain expensive categories may overrun and not be highlighted if only the man-hours are monitored.

Programmes and Schedules

A project must have a master programme, which is a summary of the detailed networks built up from logic arrow diagrams or precedent networks. These are usually fed into the computer and printouts obtained.

Apart from establishing the basic logic and highlighting the original critical path, the effective use of a computer program until the end of a project has not proved to be too successful. A mistake often made initially is to start the planning in too much detail, which then takes too long to prepare for the computer.

It is essential to have a key objective for the early stages of the project, until the detailed network indicating critical and sub-critical paths is established, which is normally a few months into the project. The key objective is hinged around major equipment deliveries, construction periods, and commissioning.

To suit the key dates the various disciplines are scheduled in detail as follows.

Engineering:	By tasks, design, technical specification, surveys, studies, etc.
Draughting:	Number of drawings by area, module, or discipline, when issued for construction.
Procurement:	Enquiries issued, orders placed, equipment delivered to site.
Construction:	Progress by discipline together with weighted man-hours.
Commissioning:	By module, consisting of all the items of equipment and ancillaries that can be commissioned as a unit.

The various hand-over stages can be monitored by certificates signed by the client plotted on S-curves.

During project execution there should be continuous monitoring of progress. A particular problem is the 90 per cent syndrome, where reports are favourable until 90 per cent completion and the last 10 per cent creates a considerable overrun in man-hours and time.

Engineering

The cornerstone of project control is a proper regard for time, particularly during the engineering phase. Time is irreversible, and its costs are irrevocable.

The engineering phase is one of the most difficult phases to control accurately since it depends largely upon firming up of the complete scope of the work so that the equipment can be selected and the foundations, etc. can be designed around the selected equipment. Before the engineering phase has proceeded too far, a series of technical reviews should be made by independent persons reviewing such items as chute design, pipeline velocities, design allowances, froth factors, and factors of safety for the various disciplines.

The electrical and instrumentation phases should be closely monitored since they are normally the last phases to receive finalized information and, in the field, the first phases needed for commissioning.

The various engineering tasks should be listed with reference to the key dates, being broken down into such items as

- Preliminary design
- Site plant plan
- Freezing of P and I (piping and instrument) diagrams
- Preparation of equipment lists and technical specifications
- Single-line electrical diagram
- Issue of enquiries
- Review of tenders
- Final design.

The items above can then be weighted on a man-hour basis giving credit only when the task listed is of value to the next discipline, e.g. 85 per cent credit given when equipment is issued for enquiry. An S-curve can be developed, and the actual progress can be measured against the planned progress at weekly discipline meetings and monthly review meetings with the project

EST. AREA	BUDGET M/HRS	WEIGH'D FACTOR	% COMP.	WEIGH'D % COMP.
0	2416	,01483	54,94	0,8
1	4101	,02517	87, 34	2,2
2	42303	,25968	94,97	24,7
3	44116	,27081	94,82	25,7
4	15254	,09364	80,15	7,5
5	31599	,19397	86,33	16,7
6	13441	,08251	62,89	5,2
7	4549	,02793	84,01	2,3
9	5125	,03146	89,54	2,8
TOTAL	162904	1,00000		87,9
OTHER	162904	,85988	87, 9	75,6
	26546	,14012	87,00	12,1
VARIATN	189450	1,00000		87,7

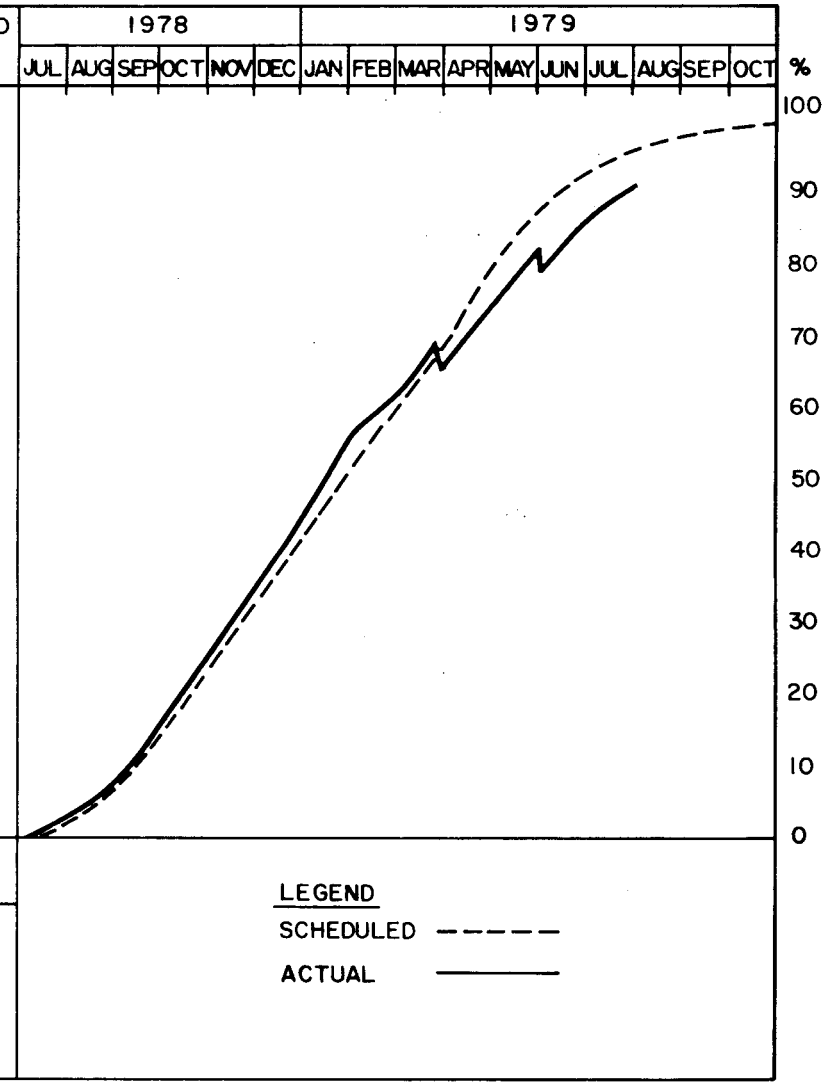


Fig. 2—Drawing schedule

manager. After the basic engineering has been fixed, the only opportunities for cost savings are by improved efficiency in project execution and productivity in engineering and construction, or by more competitive equipment and construction contracts.

Draughting

Draughting is somewhat easier to monitor and control since the number of drawings to be produced can be estimated and the man-hours allocated, the drawing production can be scheduled, and credit can be given for the various milestones achieved as follows (Fig. 2):

Drawing issued for checking	60 %
Approved by client	85 %
Issued for construction	95 %
As built	100 %

The number of drawings issued should be monitored by means of an S-curve (Fig. 3).

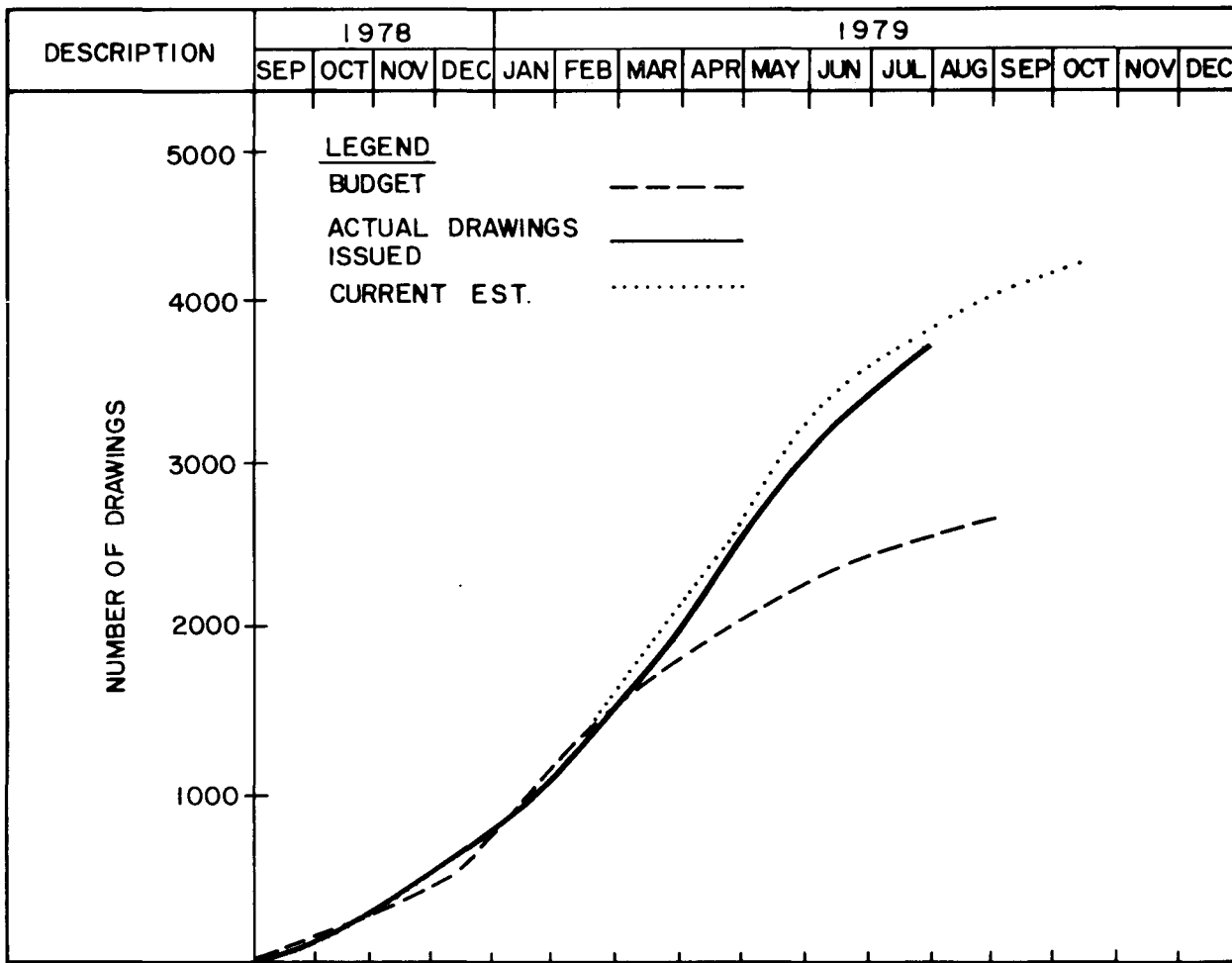
Procurement

The procurement function is the vital link between the engineering function and the construction function, and includes the issue for tender, tender review, adjudication and award, inspection, expediting, and transport functions. The procurement function depends on the receipt of the necessary information from the engineering phase with sufficient lead time for tendering, award, fabrication, and delivery to site. Each item to be finalized must be identified by code and order number, and monitored through each of its stages until delivery to site.

The inspection function is to ensure adherence to the required specifications for major equipment. Certain hold points should be established before manufacture commences so that future misunderstandings can be avoided.

Expediting is a function not to be taken lightly, and is vital to highlight early slippages that will affect the construction, installation, and commissioning.

Transportation should be co-ordinated by the procurement department, good recording and checking procedures being important, as well as quick action when there is damage. Good records are doubly important when



DESCRIPTION	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BUDGET (CUM)			415	736	1216	1501	1824	2070	2343	2454	2525	2548				
CURRENT EST (CUM)					1188	1616	2155	2657	3282	3670	3882	4048	4198	4286		
ACTUAL (CUM)	39	213	408	789	1213	1500	2009	2612	3074	3430	3768					
HOLDS		62	51	50	65	64	15	63	32	41	19					

Fig.3—Number of drawings issued

using rail transportation to save laborious cross-checking.

All the routine information should be reported weekly, and items affecting cost or programming should be handled immediately.

Construction

Construction is possibly the most spectacular of the functions, and is most likely to undergo regular inspection by the client. There are many methods to manage construction activities, but they all have the same basic requirement that the work should be broken down into measureable items.

The use of units, such as cubic metres of concrete, tons of steel (various categories), metres of piping, cable, and cable racks, number of instrument loops, etc., on S-curves forms a good basis for the measurement of progress, and the use of man-hours by disciplines is the common denominator in obtaining the weighted percentages across the disciplines for overall reporting.

After the master programme has been established, the various main contractor programmes are developed, and the 'three week rolling horizon' method of review is used to monitor progress.

When 90 to 95 per cent of the construction has been completed, a different method of control is used. This is the 'punch list' with the estimated man-hours for the completion of tasks as control, in order to get the plant commissioned.

A safety officer should be appointed to ensure, advise, and enforce safety on the site. Regular meetings should be held with all the contractors, where hazards can be discussed and accidents reviewed.

The system for the handling of site changes should be rigid, and the contractor should not start any new work until he has agreed the scope of the work, the cost, and the effect on the programme.

All the delays affecting the performance should be noted at regular site meetings. If these are not settled immediately, they can lead to frustrating meetings at the end of the project when claims are to be settled.

Every attempt should be made to agree and finalize monthly certificates, and interim estimated payments should be avoided.

If the owner supplies camp facilities, this arrangement should be carefully reviewed and adequate provision made. Poor camp facilities can lead to dissatisfaction and even riots.

Commissioning

The commissioning phase is the culmination of the efforts of the project team, and can be the most trying for all the personnel concerned, particularly with regard to client–contractor relationships. The commissioning philosophy should be developed very early in the project, especially the responsibilities of the various parties.

Early definition of the modules and sequencing of commissioning are essential if panic is to be avoided on the completion of construction, when the commissioning team require instrument air or certain reagents, which are critical to certain electrical rooms, transformers, and switchgear, or even the tailings dam. Reverse planning is essential.

An early start should be made on the development and production of plant operating manuals since these require a number of meetings with the client and operating personnel. These meetings normally highlight items overlooked by the project team that usually require extensive revisions to the instrumentation. The manuals usually include the start-up, running, stop, alarm, and emergency procedures for the plant.

Early decisions should be made as to the composition of the commissioning team. It is advantageous for the design engineers to commission the plant, but the site packages must be carefully negotiated, particularly if the site is remote, since long hours will be worked, possibly on single status, and could last for six to eight months.

Client Acceptances

The procedures for client acceptances should be agreed, including the detailed level of inspection required, the certificates and signatures required, and, particularly, the transmittal of responsibility under the Mines and Works Act.

Safety

A new safety drive is normally required at the commencement of commissioning because construction workers have become used to a 'dead' plant and are not aware that the plant is now being energized and is dangerous. A visible system of tagging and enclosing areas, and a rigid lock-out procedure are essential to safety.

Close-out

It is just as important to close-out a project as to start it.

The client and management contractor must discipline themselves to inspect the equipment supplied and the construction work performed. Then, in a formal manner, they

- accept the equipment and contract work on list exceptions,
- write letters of acceptance,
- release retention monies, and
- release the surety on performance bonds.

A particular effort must be directed towards settling any contractual disputes before the project staff are dispersed. If not, this can lead to frustrating work by staff who are not familiar with the detail.

Conclusion

After the control procedures for progress and quality have been established, the main drive of the project manager is towards controlling costs. He achieves this by implementing and effectively maintaining the following:

- establishing adequate control procedures,
- establishing a definitive estimate of the contract budget,
- cost coding all the work and changes,
- handling changes in the scope of the project by means of change orders,

- having an effective cost and commitment report,
- monitoring progress carefully against the standard established,
- monitoring contingency and escalation movement, and
- participating in cost forecasts.

The project manager should achieve control by exception, concentrating on variances and evaluating how much deviation can be accommodated. He does this by having effective timely reports that convey meaningful information and highlight trends, thus enabling him to take effective corrective action.

Acknowledgements

The author thanks E. L. Bateman Limited for assistance in presenting this paper, and The South African Institute of Mining and Metallurgy for their foresight in arranging a colloquium on the much-needed subject of project management in the metallurgical industry.

McGill seminars

In the first part of 1983, McGill University (Montreal, Canada) is offering the following seminars in mineral engineering, mineral management, mineral economics, and metallurgical engineering:

- *31st January to 4th February*
  Geostatistical mineral reserve estimation
  Seminar Leaders: M. David and M. L. Bilodeau
- *7th to 11th February*
  Mine planning.
  Seminar Leader: R. R. MacLachlan
- *14th to 25th February*
  Mineral project evaluation techniques and applications.
  Seminar Leaders: M. L. Bilodeau and N. Papanicolaou.
- *28th February to 4th March*
  The financing and implementation of mineral projects.
  Seminar Leader: P. Glenshaw
- *7th to 11th March*
  A systems approach to strategy, organization and the management of change.
  Seminar Leader: T. E. Hawkins
- *14th to 28th March*
  Mineral processing systems
  Seminar Leaders: J. A. Finch and A. Laplante
- *25th to 27th March*
  Column flotation
  Seminar Leader: J. A. Finch
- *11th to 15th April*
  Occupational health and safety in the minerals industry.
  Seminar Leader: N. Rowlands
- *18th to 22nd April*
  Extractive metallurgy of zinc
  Seminar Leaders: J. E. Dutrizac and W. M. Williams

For further information or registration, contact Lorna McFadden, Department of Mining and Metallurgical Engineering, McGill Univeristy, 3480 University Street, Montreal, Quebec, Canada H3A 2A7. Telephone (514)392-5426, Telex: 05-268510.

Chinese coal

World Coal and the China Coal Society have announced plans to sponsor the 'China Mines Investment and Marketing Seminar'. This is the first international seminar dedicated solely to examining the investment and marketing potential of the Chinese coal industry. The seminar will be held from 18th to 26th March, 1983, with an optional post-seminar mine tour that will last until 31st March.

China's coal industry is one of the world's greatest potential markets for investment. Coal now supplies 70 per cent of the nation's energy and, to meet ambitious production goals, the coal industry of China must expand and modernize. To do so will require massive capital investment from abroad, as well as technology transfer and equipment. To accomplish these goals, the coal industry has been given permission by the State to strike joint-venture agreements with foreign companies as well as ample revenues to purchase equipment and technology.

The purpose of the seminar is to allow delelates to make initial contacts with key personnel of the Chinese coal industry and to learn from the Chinese themselves how to establish a functional business relationship in China.

For further information, contact Stephen J. Schneiderman, *World Coal*, 500 Howard Street, San Francisco CA 94105, U.S.A. Telephone: (415) 397 1881, Telex: 278273.