# Capital and cost control systems used in the establishment of the Grootegeluk Coal Mine*

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**SYNOPSIS**

The paper sets out briefly the methods used for the planning and control of the construction work at Grootegeluk Coal Mine near Ellisras, Transvaal. It includes a discussion of the programming, the updating of programmes, and the progress reporting.

**SAMEVATTING**

Die referaat gee 'n kort uiteensetting van die metodes wat gebruik is vir die beplanning en beheer van die konstruksiewerk by die Grootegeluk-steenkoolmyn naby Ellisras, Transvaal. Dit sluit bespreking van die programmering, die bywerking van programme en die vorderingsverslaggewing in.

## Introduction

A project of the magnitude of the Grootegeluk Coal Mine at Ellisras, Transvaal, called for effective administration services to continuously update and control the expenditure. This paper highlights a few aspects of those services.

In the initial stages of any project, capital estimates and preliminary designs have to be prepared. A provision for contingencies varying from 5 to 25 per cent is usually added to these preliminary estimates to allow for the uncertainty and lack of detail at this stage. As more details and information become available, the amount allowed for contingencies is reduced to more realistic levels for each item.

At the South African Iron and Steel Industrial Corporation Limited (Iscor), when feasibility studies have shown a project to be viable, a detailed schedule of capital expenditure forecasts is prepared for submission to the management for approval. A detailed motivation of the necessity and profitability of the project is also submitted. Unlike the situation in the private sector, the necessity for a project may over-rule the profitability aspect when it becomes a national priority.

The object of the capital expenditure forecast is to obtain an estimate of the capital requirements of the planned project so that a capital budget can be drawn up and also to obtain approval from the management for the planning of future facilities. As Iscor's source of finance is not unlimited, projects are evaluated on a priority basis when funds are being allocated.

## Economic Evaluation and Control

As in the private sector, Iscor has to choose among alternative capital-investment opportunities. For new projects, its Industrial Economic Services and Evaluation Section performs a dual task.

(a) It calculates economic criteria on the basis of long-term future projections so that the management can evaluate the proposed project.

(b) It reports continuously during the construction period of the project. The management is kept informed of developments during the construction and of their expected effect on the economics of the project.

The following are reported to the management.

(1) *D.C.F. rate of return.* From this, the management can evaluate the project in terms of capital outlay. It can thus be used as a priority measure where finance is a problem.

(2) *Break-even cost per unit.*

(3) *Minimum yield per unit* to obtain a specified objective and minimum escalation rate to absorb the effect of the expected cost escalation. This information is of primary importance, especially to the Marketing Department, during negotiations and the placing of sales contracts.

(4) *Fund requirements of the project.* This information is usually employed by the Financial Department for their financial planning.

(5) *Sensitivity analysis* with reference to the main cost and income elements.

(6) *Recovery period of capital invested.*

## Information Required by Project Personnel

The information that is used by the Industrial Economic Services and Evaluation Section for economic evaluation of any project must be prepared by the responsible project personnel according to a standard format. This format requires the information for the capital expenditure and operating costs for a predetermined production period to be supplied on a cash-flow basis divided into six-monthly periods. The information must be on a cash-flow basis so that the interest can be calculated and over-financing for the specified period can be avoided.

The effective control of cash flow is essential when one considers that, in the financial year 1975/76, the various projects in which Iscor was involved amounted to 900 million rands. Over-financing for any period can therefore involve Iscor in large losses in interest, etc.

The project personnel supply two types of information:

(i) a historical portion

(ii) a cash-flow projection into the future.

In the latter, the information reflects the same price level (e.g. June 1979 price levels).

A further estimate is required for the expected cost escalation based on the escalation clauses of the different contracts that make up the project. Should this infor-

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mation not be provided by the project personnel, then an average figure compiled by Iscor is used for the projection of escalation.

For the calculation of replacements and excess values, an indication of the expected economic life is required.

### Forecast of Capital Expenditure

Capital forecasts are scheduled to relate to the delivery periods required for the establishment of plant and equipment to cater for production output. At Grootegeluk, certain equipment required for the initial stripping and establishment of the site was to be used for the initial production but would have to be supplemented at a later date as the output increased.

The project was scheduled to provide details and capital requirements under the following major headings:

(1) *Mining.* Buildings, mining equipment, and services.
(2) *Beneficiation Plant.* Foundations, buildings, and equipment.
(3) *Town Development.* Housing, infrastructure, apprentice training, recreational facilities, etc.
(4) *Other Housing.* Single quarters, facilities, married quarters, compound facilities, and infrastructure.
(5) *General Services.* Power, water and sewerage reticulation including main water-supply facilities.
(6) *Workshops and Stores.* Foundations and buildings, equipment, machinery and tools.
(7) *Offices and Changehouses.* Foundations and buildings, equipment, security, communication, etc.
(8) *Services.* Road vehicles, cranes, personnel carriers and sundry equipment, air field, and railway lines.
(9) *Sundries.* Purchase of land, site establishment, mine preparation, pre-production operating capital, project management, and hot-commissioning expenditure.

These headings were further subdivided to facilitate the control of expenditure.

The forecast of capital expenditure is updated annually taking into consideration cancelled projects escalation, scope revision, and new projects. It incorporates the following additional information:

(1) Planned commissioning date
(2) Latest capital estimates
(3) Estimated value of work done
(4) Estimated value of work outstanding
(5) Forecast of outstanding expenditure over the remaining period of construction divided into six-monthly periods, etc.

With the forecast of capital expenditure as a guide, the main headings are further broken down to enable a proper definition of scope to be drawn up. The reason for this is to ensure that proper planning and control are maintained throughout. In addition, the accuracy of the capital estimates can be ascertained and controlled. The mining facilities, for instance, are grouped as follows:

Explosives, magazines, silos, and equipment
Drills and drilling equipment
Shovels and equipment
Rear-dump trucks
Bulldozers
Road graders
Explosives trucks and Anfo mixing trucks
Watering trucks
Road compactors
Compressors
Mobile lighting units
Mobile pumping units
Dewatering trucks
Mobile workshops and service vehicles
Light motor vehicles.

The complete detailed definition of scope now forms the basis for future control and delegation.

### Financing

The normal procedure for Iscor is to finance projects from internal sources and medium-term to long-term loans.

The Grootegeluk Mine Project was started with the above means of financing in mind, but the decision to proceed with the project early in 1974 coincided with a steep downturn in the economic climate and the simultaneous decrease and virtual non-availability of long-term overseas financing for South African projects. The change in the economic climate and the uncertain prospects for an early upturn resulted in a cut-back in Iscor's planned expenditure on expansion projects, which of necessity also restricted the development of the Grootegeluk project.

At that stage, however, approximately 90 million rands had been committed mainly on the development of the infrastructure, opening up of the pit, and construction of the crushing and screening sections of the beneficiation plant. Iscor was therefore forced to investigate various alternative methods of developing and financing the project from local sources.

*Leasing*

It was decided that the beneficiation plant should be developed by means of leasing facilities to afford the private sector the opportunity of participating in the project and at the same time satisfying Iscor's financing needs by its own efforts, instead of turning to the State as a shareholder for the provision of the capital. Furthermore, leasing of the plant allowed for the immediate utilization of some of the vast tax benefits Iscor had built up during its big expansion phase. Expansion had been embarked on during the 1960s and had just been completed. Otherwise, such expansion would have been possible only at a very much later stage.

Iscor's award to the Standard Bank Group of the bridging finance and lease contract, which amounted to about 110 million rands, made financial history in South Africa. At the time it was one of the biggest plant-leasing contracts ever written in the country, and even in world terms the deal was a large one.

Stannic tailored the lease for the Standard Bank Group and was assisted by UDC/GATX Leasing, whose sophisticated computer program was an essential 'tool' in the compilation of the financial elements of the rental computations. Two banking consortiums tendered for the provision of bridging finance and leasing facilities: one comprised three commercial banks, and the other was made up of the Standard Bank Group and UDC/GATX Leasing.

The tender conditions called for firm quotations both for bridging finance during the construction period of the plant and for lease finance thereafter. The whole plant was subdivided into sections, and each section was the subject of a separate lease, although in practice there was one single lease agreement with addenda covering each financing stage. Iscor requested quotations for leases of 10, 15, and 20 years (tenderers could quote for one or more), and prescribed a rental pattern designed to suit the lessee's estimated cash flows over the contract period as a whole. Rentals were to be payable six-monthly in arrear, and the rentals for each year were to be 10 per cent higher than those for the previous year, with a final balloon rental of 20 per cent of plant cost at the end of the 10-year lease, and a 10 per cent balloon payment at the end of the 15-year lease. There was to be no balloon payment at the end of the 20-year lease.

All the necessary documentation had been designed by Iscor and its advisers (Finansbank), and copies of this formed part of the tender conditions.

The plant was constructed by a turnkey company (Grootegeluk Construction Company), which remained under the control of Iscor throughout the construction period, and, as each section of the plant was completed, it was sold by the turnkey company to the lessor and a lease commenced from that date in respect of that section. Once all the sections had been completed and purchased from the turnkey company by the lessor, the whole plant was subject to the lease.

The lease was a 'net' lease in the sense that all risks of ownership rested on the lessee, who would naturally be responsible also for licences, taxes, maintenance, insurance, and running costs.

In responding to the tender, the Standard Bank Group quoted as requested in the tender conditions but, in addition, *offered a residual value lease as an alternative.* In terms of this lease, there would be a primary lease period of 10 years, with rentals escalating exactly as required by the tender conditions, and at the end of that primary period the plant would have been written down to a value equal to 30 per cent of its original cost. At that point, Iscor would be entitled to ask the Standard Bank Group to sell the plant to Iscor at such a value as would be considered to be 'fair value'. Alternatively, Iscor would have the option to continue the lease for a further 5 years at rentals based upon the 30 per cent residual value. These rentals would be even, payable at six-monthly intervals in arrear, and 'linked' to average best lending rate and to tax rates.

At the end of the second period of 5 years, the plant would have been written down to a value equal to 10 per cent of its original cost, and at that point Iscor would again be entitled to purchase the plant from the lessor at 'fair value' or to continue the lease for a further period of 5 years on a basis similar to that in respect of the secondary period. Finally, after 20 years the total cost of the plant would have been amortized to nil value, and Iscor would be entitled to request the Standard Bank Group to sell the plant to Iscor at 'fair value'. However, the option would still be available to Iscor to request a further extension of the lease by another 5-year period at a fair market rental. (As the plant would have been entirely amortized by then, the fair market rental would be a very reasonable one.)

Iscor used its own computer programs to evaluate the leases. This was done strictly in accordance with tender conditions, and, after awarding the tender to the Standard Bank, Iscor elected to accept the residual value lease.

The final choice as to which of the two consortiums should be awarded the tender rested with the Board of Iscor, and the vote taken was on an anonymous basis — that is, the directors of Iscor were not aware of the name of the winning consortium until the vote had been taken and the financing contracts approved. This was considered to be an appropriate way in which to adjudicate on such an important and complex financial transaction.

After the lease had been finalized, funds became available and the project continued.

## Application for Funds

After approval had been granted to proceed with the project, the funds had to be approved and allocated for the various items according to certain procedures. The funds had then to be applied for, not exceeding the amount included in the estimates. They had to be properly motivated and to correspond to the scope applicable. If this amount was exceeded, an *ad hoc* application had to be submitted for the additional funds required to complete the project.

The *ad hoc* funds provided for in the estimates of expenditure under the contingencies sum were included in the original estimates to ensure that funds were available for the completion of the project in the event of unforeseen items.

The value of the orders was committed against the approved funds at the time the order was placed, and not at the time of payment, to ensure that no over-expenditure occurred. The application form was intended to constitute a control document and not merely a stereotyped application for getting a project started.

The practice of including some or other percentage or amount in a vote application to cover contingencies is undesirable. When a project is properly planned and allowance is made for the cost of each element that can be foreseen at the time, then should further requirements become necessary at a later date, a supplementary application for funds should be submitted with the justification for the application clearly annotated. The less definition of the work to be done there is attached to a voted amount (and nothing is more indefinite than 'contingencies'), the greater is the human tendency to use it to the full.

## Control of Voted Funds

Effective control of funds is possible only where there is a suitably detailed definition of scope and estimates of prices to pinpoint the aim and provide figures for comparison with subsequent actual commitments and expenditure. Only by being able to identify the specific elements involved when appreciable differences arise between estimates and actual costs does it become possible to decide whether and where remedial measures can be taken. At the same time, purposeful statistics

and trends become available to provide a means of ensuring that similar projects in the future are based on sound (or more realistic) assumptions and principles.

A detailed definition of scope also gives essential meaning to a vote. Control against the total value of a vote is no control at all. Half of the project may be grossly over-estimated and half grossly under-estimated, with an overall net balance. Even more ludicrous is the project where the cost is over-estimated to a considerable degree 'to be on the safe side' and the end result, owing to a 'saving' being revealed against the vote, leads to the false assumption that the project was administered very effectively.

The effectiveness of controlling funds depends on the extent to which cost consciousness is projected by the personnel of all ranks into every decision involving the use of funds. Any variance or contemplated extra should be viewed not only as a percentage of project cost but also as a sum of money. An excess of 10 per cent may be dismissed too easily as being of no consequence but, when related to a major capital plant complex costing 100 million rands, would amount to 10 million rands. Numerous 'small' extras on various projects also have a significant impact on costs when viewed in total.

Where it becomes evident during the implementation of a capital project that elements of cost require revision, the position should be reported immediately and not be left to appear later as over-expenditure against a vote. Early analysis of potential variations allows time for re-assessment of the financial objectives and for possible remedial measures.

To facilitate financial and cost control, a computerized accounting system was developed, containing the following information:

1. *Progress Report on Votes and on Capital Orders*
   - Vote number
   - Description
   - Amount authorized
   - Amount committed
   - Uncommitted balance
   - Expenditure this month
   - Amount paid
   - Amount due for payment
   - Total expenditure to date
   - Unexpended balance
   - Responsible Project Engineer
2. *Detail of Expenditure per Vote*
   - Vote number
   - Transaction type
   - Batch number
   - Date of document
   - Document number
   - Expenditure I.D. code
   - Signing authority
   - Article number
   - Value
   - Description.

This accounting system, together with a hand-card system, enables timeous control of expenditure, and ensures that no purchase can be made or contract awarded before the required funds are obtained for the vote in question. This accounting system is also used for the forecasting of cash flow and the measurement of financial progress.

Throughout the construction period at Grootegeluk, income and expenditure were accounted for by means of the financial and cost-control system. Debtor's and creditor's accounts, salaries and wages, and procurement of stores and materials, etc., were handled on site and were accounted for by means of the normal procedures applicable to operating mines.

## Evaluation of Tenders

Iscor's normal procedure is to invite tenders for goods or contract work. In the Grootegeluk project, some contracts were awarded on a turnkey basis, others for the supply of machinery only, and still others as erection contracts in which Iscor supplied the materials and machinery.

On contracts and orders, very few tenderers are prepared to quote on a fixed-price basis. Consequently, escalation clauses and/or formulae have to be incorporated in the ultimate contract or order to protect the caller for tenders against unjustifiable claims. The 'advantages' or suitability of the different bases of calculating price variations and of the various price indices that are available vary in relation to time, equipment, and country. In the adjudication of tenders, the basic tender price is modified to ensure that all tenderers are on a technically comparable standing (Table I). These technically comparable prices are evaluated financially taking into consideration the various escalation formulae, terms of payment, rates of exchange, etc., to arrive at a final as-built and installed contract price. These adjustments have shown on numerous occasions that, where a tenderer has quoted the lowest price technically, escalation adjustments have swung the tender in favour of others.

It is Iscor's policy to require tenderers to include as much South African content in their tenders as is reasonably possible. A preference factor is attached to such local content during the tender-evaluation procedures. It must be remembered that, when the local-content factor swings the adjudication in favour of a tenderer who would otherwise have lost on price, the rand value of the preference constitutes a 'loss' factor to Iscor, or, in other words, a donation to secondary industry in South Africa. This should be kept in mind when the economics of the project are examined. Delivery time is also an important consideration in the adjudication of tenders.

## Principle of Escalation

The actual costs during construction are normally well controlled once the tender has been awarded, but a fairly unpredictable cash-flow variable is the amount of escalation to be paid on the certified value of the work done. An example is provided by a contractor who executes a contract worth 5 million rands with an assumed escalation of 1 per cent per month. By being slow in the first part of his contract and increasing his resources in the last part of his contract, the centre of gravity of the escalation period is shifted. If this contractor manages to shift this centre of gravity by two months, an extra

TABLE I

COMPARISON OF TENDERS FOR REAR-DUMP TRUCKS AFTER TECHNICAL AND FINANCIAL EVALUATION

| Stage of comparison | Tenderer | | | |
|---|---|---|---|---|
| | A | B | C | D |
| 1. Basic tender price (excluding spares) | 1 207 122 | 1 092 333 | 1 459 692 | 1 124 600 |
| 2. Technical comparable price (excluding spares) | 1 208 818 | 1 186 671 | Not evaluated, price too high | Not evaluated, technically unacceptable |
| 3. Spares | | | | |
| 4. Cost of security | 410 | 1 172 | | |
| 5. TOTAL 2 + 3 + 4 | 1 209 228 | 1 187 843 | | |
| 6. Financially comparable price, including spares, estimated escalation, present value of cost of financing at commissioning date, estimated rate of exchange variance | 1 327 600 | 1 276 800 | | |
| 7. Price 6 less 10% preference allowance for local manufacture | 1 210 000 | 1 211 800 | | |
| 8. Percentage local manufacture | 100% | ≈54% | | |
| 9. Present value of difference in operating cost | | | | |
| 10. Difference in cost of civil work | | | | |
| Estimated GST (A) | R42 606 | | | |
| (B) | R45 781 | | | |

2 per cent escalation will be due to him, R100 000 in this example.

It is accepted that escalation, if awarded in a tender, is supposed to compensate the contractor fairly for increases in the cost of elements *beyond his control.*

Once a contractor has submitted a construction programme, it is well within his control to adhere to his programme except for *force majeur* and delays by the client. It is often found, however, that contractors lag behind their programme for a considerable time early in their contracts. When the client then starts to apply all sorts of pressures, they increase their resources and catch up with their programme or decrease the lag considerably. This situation often results in a shift of the centre of gravity of the escalation payment period, and results in extra payments to the contractor for cost increases outside his control, but that would not have occurred if he had acted in accordance with his obligation to adhere to his programme. In effect, these extra escalation costs were *within his control.*

If a contract includes escalation, it should

(a) fairly compensate the contractor for cost increases outside his control as long as he adheres to the contract — including keeping to his programme;

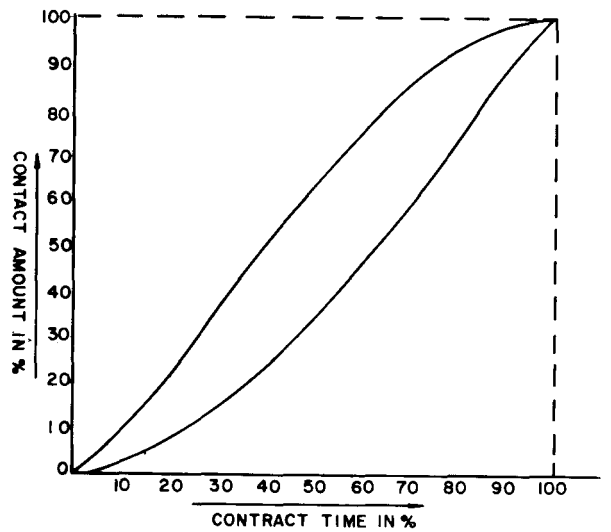
(b) include protection for the client when the contractor does not adhere to his programme; if he executes the work later than programmed as a result of his own doing, the contractor should bear the extra cost increases;

(c) if the contractor is ahead of his programme, he is paid escalation on the certified value of the work at the time it was completed; this may sound as if the client wants to eat his cake and have it, but it is quite correct for escalation is not a tender item to be speculated with; it has nothing to do with the tendering process of pricing rates versus work items but is an extraneous 'insurance' for the contractor to cover cost increases *beyond his control;* the 'premium' for this 'insurance' is paid by the client in the form of escalation payments to the contractor; if he finishes earlier, it means that the particular 'insurance' carried by the client is obtained at a lower 'premium' and the benefit goes to the client.

At Grootegeluk the contractor was required to submit his estimated programme for work done at consecutive intervals during the construction period. Fixed tolerances were then applied to this programme of work done and the two envelopes thus obtained had the appearance of a banana on the graph paper and are referred to as banana curves. Escalation is then limited to the lower limit curve of the banana.

(a) *Banana Curves*

If a contract progresses normally and the value of the work done at any time is plotted against a time scale of the construction period, an S curve is produced. In the first months, the contractor builds up his resources, has low production, and then attains a planned production




(CURVE DATA)

| CALIFORNIA BANANA FOR CIVIL WORKS | | | |
|---|---|---|---|
| TIME % | LOWER LIMIT % | MEAN % | UPPER LIMIT % |
| 0 | 0 | 0 | 0 |
| 5 | 0,50 | 2,75 | 5,00 |
| 10 | 3,25 | 6,63 | 10,00 |
| 15 | 5,75 | 10,63 | 15,50 |
| 20 | 8,50 | 15,25 | 22,00 |
| 30 | 15,25 | 25,38 | 35,50 |
| 40 | 24,00 | 36,50 | 49,00 |
| 50 | 34,00 | 48,25 | 62,50 |
| 60 | 46,25 | 59,38 | 74,50 |
| 65 | | | 80,00 |
| 70 | 60,00 | 72,50 | 85,00 |
| 75 | | | 89,00 |
| 80 | 73,25 | 83,12 | 93,00 |
| 85 | | | 96,00 |
| 90 | 86,75 | 92,38 | 98,00 |
| 95 | | | 99,00 |
| 100 | 100,00 | 100,00 | 100,00 |

**Fig. 1—The California money banana**

rate, which tapers down in the last months of his construction period.

If plus and minus variations to an ideal S curve are allowed, say 2,5 to 5 per cent initially, 10 to 15 per cent at normal production, and 5 to 2,5 per cent during the final phase of construction, two S curves are obtained originating from and terminating in the same points. This envelope, the banana curve, is called the permissible value of work done (Fig. 1)

It is possible, therefore, to express the progress of the works in financial terms by the use of banana curves. If acceptable banana curves can be established before the tender is awarded, escalation can be limited to the lower acceptable deviation from the intended programme. Iscor would pay no more than the slowest progress on the banana, provided the contractor's delays were because of his own doing.

(b) *Banana Curves for Civil-engineering Work*

The civil-engineering disciplines have a long history of applying banana curves to the progress of the works, the practice originating in the U.S.A. The California money banana is an empirical statistical control method for the evaluation of progress and indicates trends for civil contracts executed with a continuous programme. Most civil-engineering contracts, also of a multi-disciplinary nature, should progress, money-wise, within the limits imposed by the California banana.

If the curve representing amounts certified for work done by the contractor keeps within the banana, all is normally well. If the contractor's curve flattens towards the lower limit or crosses the lower limit, one can expect to find the contract in serious trouble.

In the enquiry document, Iscor asks for the inclusion of the California-banana limitation for progress and escalation. The contractor may modify it in his tender, but in that case the additional escalation costs to Iscor can be assessed.

(c) *Mechanical/Electrical/Plant Erection Works—Banana Curves*

Banana curves for exclusively mechanical or electrical contracts, or for combined plant-erection contracts, do not yet exist, but nothing prevents Iscor from assessing curves during the enquiry period. The important aspect is to agree to the use of these curves with the contractor *before the award of the contract.* Once a banana is agreed on, escalation becomes predictable and measurable with far greater accuracy.

(d) *Changes in the Contract After Its Award.*

Contracts normally change during their course of execution, requiring adaptation of the control measures.

(i) *Extension of time — no increase in value.* Where an appreciable extension of time is allowed, the banana is recalculated from the time the extension occurred.

(ii) *Increase in value — no extension of time.* Contracts normally change owing to minor variations being ordered by the client, for example a request for a higher-quality substitution of an item, or change in quantities but not in scope (more rock, less soft ground), etc. The contract is increased, not substantially as to affect the time, but financially. The banana is recalculated on the same time basis.

(iii) *Substantial increase in value — no extension of time.* When the contractor is asked (negotiated) to execute additional works that are to be completed in the original time, the banana is recalculated.

(iv) *Increase in time and money.* The banana is recalculated.

The following advantages arise from the linking of escalation to the contractor's programme:

(a) Predictable maximum escalation costs.

(b) Increased accuracy in the prediction of cash flow for the contract.