

Mineral Resource Management and Economic Value Added

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SYNOPSIS

Mineral Resource Management has become a popular component of the restructuring exercises that are prevalent in the minerals industry in South Africa, and worldwide, in recent times.

All too often, the reason for introducing Mineral Resource Management is poorly understood, with the result that a redistribution of previous activities and functions is the outcome of the exercise. As a consequence of this, sub-optimal or minimal improvements in operational and company performance are realised.

In order to develop a comprehensive and strategic approach to Mineral Resource Management, it is important to understand the fundamental purpose and objective of its development and introduction, and to be able to measure its success as it is implemented.

The concept of Economic Value Added (EVA) provides an ideal vehicle for this. Indeed, Mineral Resource Management is the primary activity that enables an EVA approach to be adopted.

This paper attempts to illustrate that Mineral Resource Management is EVA, and that this requires a fundamental shift in the way work is done in the new organisation. It also quantifies these aspects through a number of modelling exercises, which show the measurable effects of successful Mineral Resource Management.

INTRODUCTION

The author has been involved with a number of exercises in various companies, where Mineral Resource Management (MRM) has been

introduced. The concept of MRM has been around for a number of years now, and its implementation has met with varying degrees of success.

At best, MRM has resulted in an integrated approach to resource planning and management, with a varying degree of effectiveness along the value chain. In this regard, usually the geological modelling and evaluation aspects are well done and understood, with diminishing effectiveness and competency along the value chain, into the financial valuation and planning and control areas. This is understandable, with the activity being relatively young, and with most incumbents being from a geological background. Figure 1 illustrates this effect diagrammatically, where competency and knowledge tends to diminish along the value chain, but increases at the sales and distribution areas, as a result of the relationship between market requirements in terms of quality, related back to planning, especially in the base metal and industrial mineral sectors.

At worst, MRM has simply resulted in a redistribution of various functions, with the result that professional jealousies and self-preservation issues have been overriding to the intended outcome.

As with all change initiatives, there has to be a clear, measurable strategic purpose for the change to be successful, and one into which the participants/stakeholders can buy, because they will have to take a fundamentally different approach to the way they do business and work.

A paper published by the author entitled "Maximising shareholder wealth through effective Mineral Resource Management", (Macfarlane, 2000), identified the role played by MRM in growth in shareholder value, and the role played by MRM in the short and long term, in maximising shareholder wealth.

This paper identified the concept of Economic Value Added as being one, which provides a linkage between short, and long-term business objective realisation through MRM, as well as providing the background for evaluating the effectiveness of MRM in the Company.

Financial Managers have attempted for some years to utilize the concepts of EVA as developed by Joel Stern, but without much success

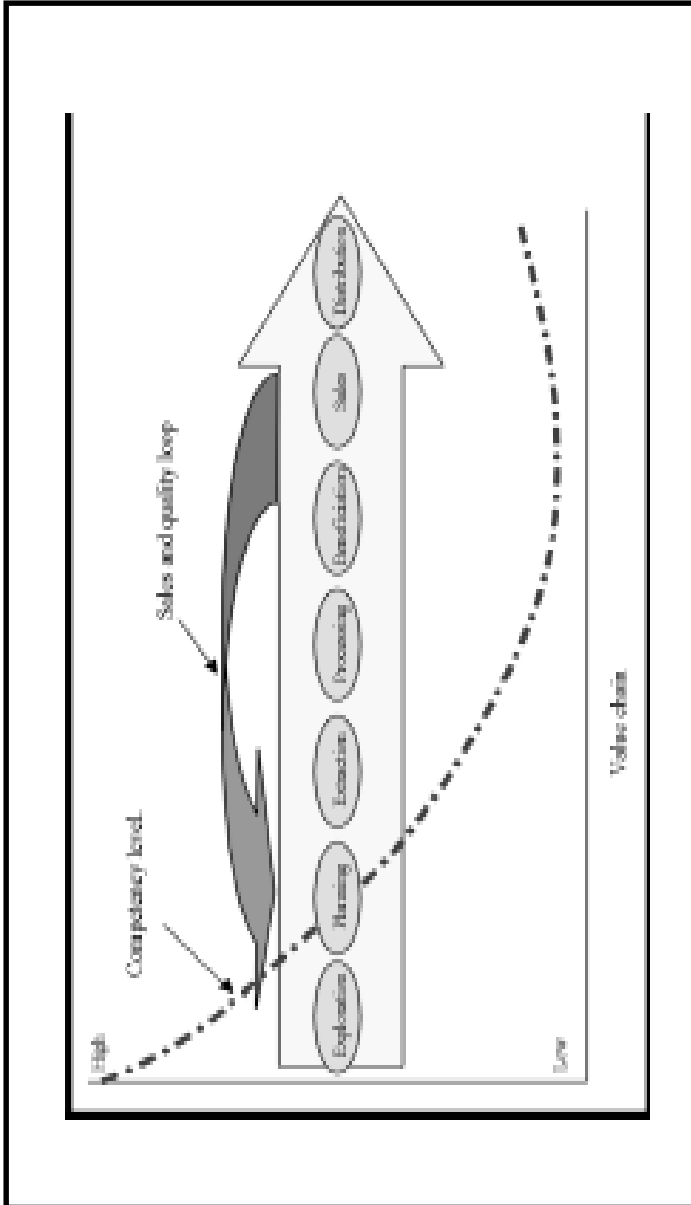


FIGURE 1
Competency along the value chain in MRM

in the minerals industry. This may have been because of a lack of understanding or acceptance of the concept as opposed to practical mining, or as a result of the work system being unready or unsuitable for the concept.

Much has now changed, and it is the purpose of this paper to show that the implementation of MRM within process based organisations provides the opportunity to adapt and implement EVA to the mining business.

THE NEW ENVIRONMENT

As stated above, Mineral Resource Management has been around for some time, in a number of companies in South Africa. Moreover, the implementation of an integrated "mine engineering" department or division, which is the custodian of short and long term mine planning and design has been in place in mines worldwide for many years. However, changing circumstances have required a new look at how these organisations are structured, how they function, and how they can be more effective in adding value to the company. Amongst these changing circumstances are the following.

- Margin squeezes have been driven by a down-turn in commodity prices in most sectors, accompanied by diminishing high grade resource availability, and a move towards larger, low grade deposits, often situated in remote locations (with high associated infrastructural and contingency costs);
- A new breed of investors is in place with different expectations. Speculative investors are after short-term gain, in terms of earnings, with an expectation of medium term growth in value. In other words, rewards commensurate with risk levels, which may be perceived as high compared to alternative blue chip stock.
- Global investors may have new views on company performance, and the rewards accruing to themselves: reinvestment of funds for added value may be preferable to guaranteed dividend payout, and so dividend policy becomes important.

- These factors, coupled with fund scarcity, a desire for industry consolidation and increased market capitalisation amongst majors has resulted in competitiveness, leading to mergers and takeovers, driven by share price, linked directly to company performance.
- This has resulted in a focus on the search for unlocking and creating shareholder value, from within the company through improved operational performance, from simplification of structure, from risk spreading through diversification, and from creating a profile of future growth.
- Competition for investment funds, whereby attractive, alternative investment choices abound, in other sectors of the bourses than resource stocks. The result is the creation of an opportunity cost to the company, which must be quantified, if investor expectations are not realised, and investor funds are moved elsewhere.
- Value creation must be aligned to the value chain, such that maximum return on the investment in the mineral asset is realised, through a value-adding process, which results in appropriate levels of beneficiation of the ore, in order to realise the best return, through price fixing at market prices.
- This has resulted in a move by mining companies towards the creation of process based structures and organisations, which are broadly aligned to the value chain.
- The recognition of a wider range of stakeholders, placing demands for a share of the wealth created. These include local communities and economies, local and provincial governments, organised labour, aboriginal rights holders, environmental groups etc. These are embodied in the collective purpose and objectives of sustainable development of the minerals industry, and require that mining companies provide appropriate levels of social capital from their cashflows, to meet agreed commitments to satisfy the needs of these stakeholders.
- The rapid development of information technology has resulted

in the need for speed and transparency, in terms of consolidation and reporting, as well as a need for the company to become light on its feet, in terms of response to rapidly changing circumstances, in a competitive global market.

- The new breed of investor, after several notable scandals and project failures, demands legal protocols and due diligence to be exhibited, so that legal recourse is possible, in the event of failure or default.
- This has required a greater emphasis on the application of risk management in all fields of mining project development and operation.

These factors have influenced the industry in all its facets. In particular, it has resulted in the development and application of Mineral Resource Management as a key activity in the value chain. However, success has not been realised to the extent that the effort of implementation has warranted.

This is evidenced by observations from audit work that the author has recently been involved with, in various companies, and various mineral sectors.

THE ORIGINAL INTENTION OF MRM

As originally envisaged, Mineral Resource Management was to integrate key functions of geological modelling, surveying, evaluation and planning and design, such as to create a seamless transition from the identification of the Mineral Resource to the extraction of the Mineral Reserve.

This engineering of the Resource to a Reserve would be done against the backdrop of the financial objective of the company, ensuring that these objectives are realised through optimisation and re-engineering.

Whilst these objectives are still valid, they fulfill only part of the requirement for this activity to add maximum value to the value chain.

COMMON SHORTCOMINGS IN THE STATUS QUO

During the interfaces with mining organisations and software supply companies referred to above, as well as proceedings of conferences and seminars, and discussions on academic interpretation of Mineral Resource Management, the following shortcomings are apparent.

- MRM has not been fully integrated into the value chain. It is still viewed as functional support in many quarters, and viewed with suspicion by some senior management. This may be due either to a lack of delivery, a lack of understanding of the purpose of MRM, or inadequate organisational development.
- Structures are not always appropriate for delivery, and are either scarcely populated, or populated with inadequate skills or competency. People must be carefully chosen for their breadth of vision, and developed to be able to deal with the complexity of the work at hand. If this does not happen, there is a tendency to relapse towards old, familiar structures and ways of doing work.
- Competency development is often inadequate. This is due to a large extent to a paucity of appropriate training and development material and courses, a matter currently being dealt with by Universities and Technikons.
- Protocols and standards are an essential part of the development of MRM. In particular, codes such as the Samrec Code must be accepted, and then dissected, analysed and constituted for the business at hand. Compliance to these codes is not a once-a-year effort at due diligence, but instead must become the way in which work is done.
- Due to economic and business pressures, focus is often too short-term. It is the job of MRM to ensure integration of short, medium and long term planning and control. Short-term focus is often driven by management pressure or short-term incentives, and may be destroying future value for the shareholder.

- Despite the shortcomings of the "old way" of doing work, there existed a large amount of "tacit" knowledge to deal with changes in economic circumstances. Computerised systems and mechanistic processes provide the opportunity to ignore this tacit knowledge. MRM must rebuild and refocus tacit knowledge so that value is added to the value chain and the decision-making processes through the effective use of human capital. (Runge)
- More often than not, there is an acceptance that the mining process inherently destroys value, because of the fact that the Resource is finite. Such an approach tends to encourage the view that base feasibility studies become invalid once mining has commenced, because the remaining Resource has diminished. The result of this rather static view, is an NPV profile as shown in Figure 2, which shows that eventually NPV reduces to zero, once the Resource is depleted.

The work of the MRM must rather be to a) increase value through a process of optimisation, and b) to replace value through the identification of new opportunities, such that a picture as shown in Figure 3 is realised.

- There is a tendency, due to the short-term focus coupled with the declining value, to see investment as a cost. It should be reasonably easy to justify sensible value-adding expenditure, but all too often, cost reduction pressure overrides sensible decision-making.
- Incentives are sometimes paid to MRM staff, which encourages value destruction rather than value creation, through suboptimal activities, which are easily measurable.
- There is sometimes a tendency to create MRM organisations, which are manned with generalists, who have lost focus on the essential sapiential inputs, which create technical excellence.
- Overall, there is a lack of an underlying vision or theme, which should pervade the entire organisation, and which underpins the need and development of successful MRM. This theme

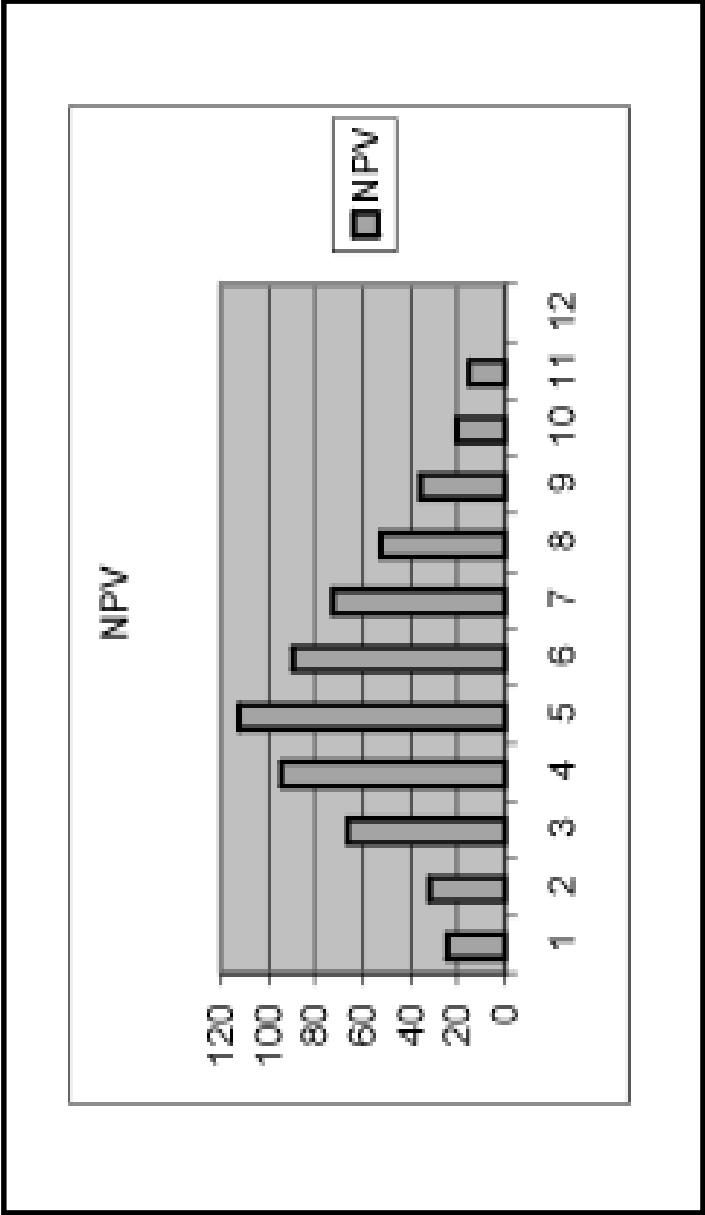


Figure 2
NPV Profile of a mining project

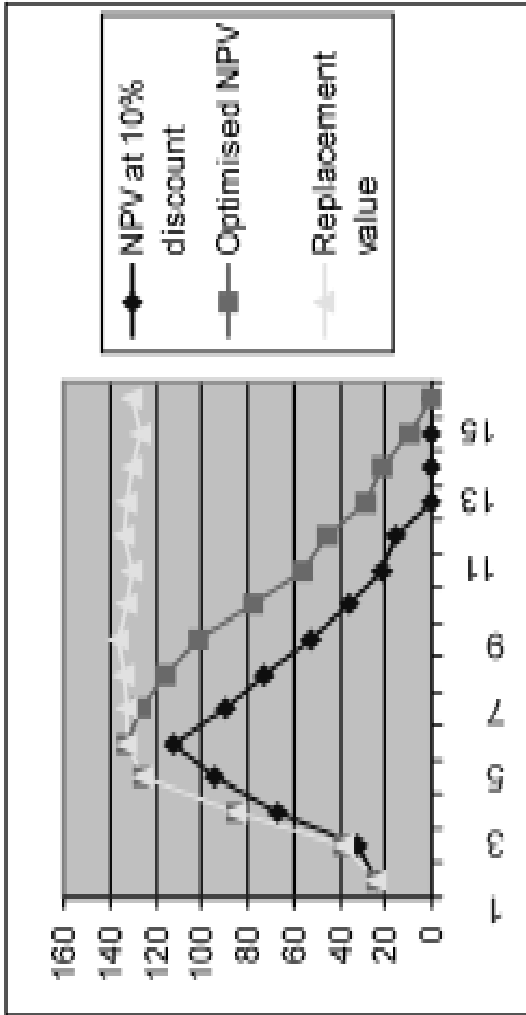


Figure 3
Enhanced value, resulting in maintaining shareholder value.

must be matched to an organisational change process, which establishes MRM as a core activity in the value chain. It is the subject of this paper to identify, analyse and adapt that theme.

THE PURPOSE AND OBJECTIVE OF THE MINE OR MINING COMPANY

The previous paper (Macfarlane, 2000) emphasised the objective function of business to be that of maximising shareholder wealth, either through dividends in the short term, or through growth in the longer term (Cockerill, 1999).

As quoted, Gitman (2000) dispels profit maximisation as being the financial goal of the company since " it fails for a number of reasons: it ignores the timing of returns, the cashflow available to stockholders and risk".

In the minerals industry, these observations are valid in that there is a temptation to forego longer-term benefits, in order to show short-term profit, thereby compromising value in order to enhance short-term gain.

Many instances exist where mines or companies have focused on short-term profitability, at the expense of investment into longer-term value. This is evidenced by reduction in development costs, exploration expenditure, timeous waste stripping, and a general reduction in flexibility, which is vital in order to reduce internal and external risk.

Frequently, the temptation to chase this short-term gain is done without adequate knowledge of the downstream effects, and without analysis of the economic impact. An interesting analysis on this problem has been done recently by Woodhall, who has shown that a mathematical relationship exists between actions now (such as development rates, reserve generation etc), and the consequences at some time in the future on production capability, taking into account the time lag that exists between the two. In other words, actions now can be used as predictors of the future.

Cashflow analysis of mineral projects is generally used to quantify asset value, through placing a discounted value on future potential cashflow streams. These models, when incorporated into optimisation tools for open pit scheduling, for example, utilising the concepts of dynamic cutoff grade optimisation, tend to direct planners to focus on high-grade reserves first, with elevated cutoff grades, within existing capacity constraints. One must be careful however not to interpret this in such a way that the high grade should be exploited at the expense of the rest of the payable resource.

Inherently, the maximum net present value will be obtained through the optimal extraction of the payable resource (payable, that is, under the conditions existent at each cashflow period), according to the profile of the grade/tonnage curve.

VALUE DETERMINANTS

Value in mining and mineral assets is thus about the short-term indicators (profit, cost) and about the longer-term asset value, as manifested by appropriate valuation techniques.

For operating mines, longer-term value is reflected through discounted cashflow analysis, which is based on the life of mine plan.

Of significant importance is to determine the linkage between the short and longer term, such that the one does not compromise the other. Herein lies the skill of Mineral Resource Management: not only in ensuring that this linkage is intact, but also ensuring that value is created, and not destroyed.

In public listed companies, these values are visible through the public reports that companies are required to publish, such as the annual and quarterly reports, and through the analyses done by mining analysts and brokers.

Short term profitability numbers are relatively simple and available through the income statements and the profit announcements of the company, and become translated into dividends or retained earnings, and manifested in ratio analyses such as earnings per share, dividends per share etc., and by comparisons of company performance to industry

cost curves and competitive performance.

Longer term value is less easily assessed, since in most cases the value listed in the Balance sheet is based on invested capital (thus assuming a zero NPV), and the value ascribed to a company is based on NPV of future cashflows (based on the Life of Mine plan), with a market premium or discount.

These values may differ from the true value of the company, since the analyst may have adjusted discount rates, or added a premium or discount based on his perception of the future riskiness of the company.

Despite this, the fact remains that value is manifested through the development of life of mine plans that have value, integrity, and a minimum amount of risk, and which are optimised on an ongoing basis in order to maintain value despite depletions.

Clearly the latter is not sustainable in the long term, due to the depletion, which is occurring, but value should be replaced elsewhere through constant search for growth opportunities externally, once internal growth is exhausted. Indeed, it is a function of good Mineral Resource Management to identify the point at which increased management effort no longer yields improved returns from the wasting asset.

These values, in the case of the listed company, translate through to the calculation of book value of share price (Net asset value divided by number of shares in issue), and to market value once premiums and discounts have been applied.

In the case of unlisted companies or operating mines, although the audit trail does not extend to share price, value is still based on cashflow analysis, which itself is based on Life of Mine planning. In the case of a sale or merger, this would be methodology most likely to be applied.

Since all of these measures rely upon the optimal extraction of the mineral asset, the role of Mineral Resource Management is of fundamental importance in ensuring that value is realised and optimised.

THE SEARCH FOR VALUE

In order to ascertain the base value of a mining operation from the perspective of Mineral Resource Management, it is necessary to do the following:

- Establish quality geological models, which identify structure, mineralogy, facies, chemical balance, grade and other applicable parameters, and which integrate this information such that a complete picture is obtained, which embodies minimal risk;
- Establish quality evaluation models, which embody appropriate evaluation techniques, which provide confidence in grade estimates;
- Establish markets and market price forecasts;
- Establish capital and operating costs;
- Establish an optimal extraction sequence and plan;
- Establish financial assumptions and forecasts (exchange rates, inflation etc.);
- Develop a cashflow schedule using calculated discount rates.

Clearly, the above is simply the development of a discounted cashflow model based on the life of mine plan of the operation. Frequently though, such an analysis would only be done for a new project, or for some new sub project within the operation.

If MRM is the custodian of value in the company, then it should take Life of Mine planning forward into cashflow analysis, as a matter of normal practice. This practice itself has limitations, though, which must be borne in mind and tackled, namely:

- The quality and usefulness of any such analysis is only as good as that of the input variables;
- The analysis is dependant on the selection of appropriate discount rates;
- The analysis is a single point solution: it does not take account of optimization;
- Input variable accuracy may be influenced by the desire to make the project work, and therefore be over-optimistic;
- The analysis does not take account of risk;
- The process must be auditable, and therefore structured against

- standards and audit trails as appropriate;
- This long-term analysis must link to short term planning and optimisation, such that short-term plans are framed in this longer-term analysis.

Cashflow analysis of Life of Mine plans should be accompanied by sensitivity analysis, which is used to identify the most sensitive key value drivers in the business.

As an example, an analysis was conducted on a copper/gold mine, and a sensitivity run was completed, which appears in Figure 4.

This analysis was run on revenues, capital and operating costs, and in this particular case, indicates that copper price is the most sensitive input parameter in the analysis. A 5% change in copper price yields a 30% change in NPV for this mine.

Factors such as dilution, recovery, grade and volume were not included, but, since they are revenue drivers, it could be assumed that they would be highly sensitive.

This analysis should drive the Mineral Resource Manager to undertake the following, since these parameters have such a significant effect on value:

- Mitigate against downside risks by analysing these variables, and reducing their variance about an expected mean value;
- Shift the mean value by positive intervention, through, for example, price fixing, recovery improvement etc;
- Establish management controls on the critical variables.

Such an analysis enables the parameters, which are the key drivers of value in the business to be identified, and these should be the subject of focus of MRM in terms of improving value or reducing risk in the business.

These will vary from operation to operation, and from commodity to commodity. The table below illustrates examples of how these may be identified in different types of mining business.

Table 1

Key MRM value drivers in various mining businesses

Gold	Coal	Base Metal	PGM's	Diamonds	Ferro-Metals
Price	Price	Price	Prices	Price	Price
Unit cost	Unit cost	Unit cost	Unit cost	Unit cost	Cost of production
MCF	Quality	Dilution	MCF	Dilution	Customer satisfaction
Grade	CV	Quality	Grade	Volume	Blend
Dilution	Ash content	Recovery	Dilution	Grade	Delivery to spec
Grade Mix	Volume	Grade	Grade mix	Market size	Size distribution
Models	Markets	Markets	Cutoffs	Size	Washability
		Stockpiling / distribution		Quality	Stockpiling/ distribution
					Impurities

Analyses such as these can be used to develop audit trails for value, by identifying these value drivers and tracking their impact on the short and long term value of the business, as shown in Figure 5.

The figure illustrates the linkage between key value drivers (denoted as Key Result Areas (KRAs) and Key Result Indicators (KRIs) and short and longer-term value.

These are linked by the statements of company performance, namely the Income statement and Balance sheet in the short term, and the Life of Mine and Risk adjusted plan, (the Business Plan) in the longer term.

This continuum then allows the appropriate form of analysis to be conducted, in order to ascertain value for the company or operation.

Although such an analysis might seem simple and somewhat obvious, in many instances the effect of variation in these key drivers or indicators is misunderstood, and therefore receives inadequate attention. Furthermore, effort may be directed at parameters or inputs, which have very insignificant effect on the value of the company.

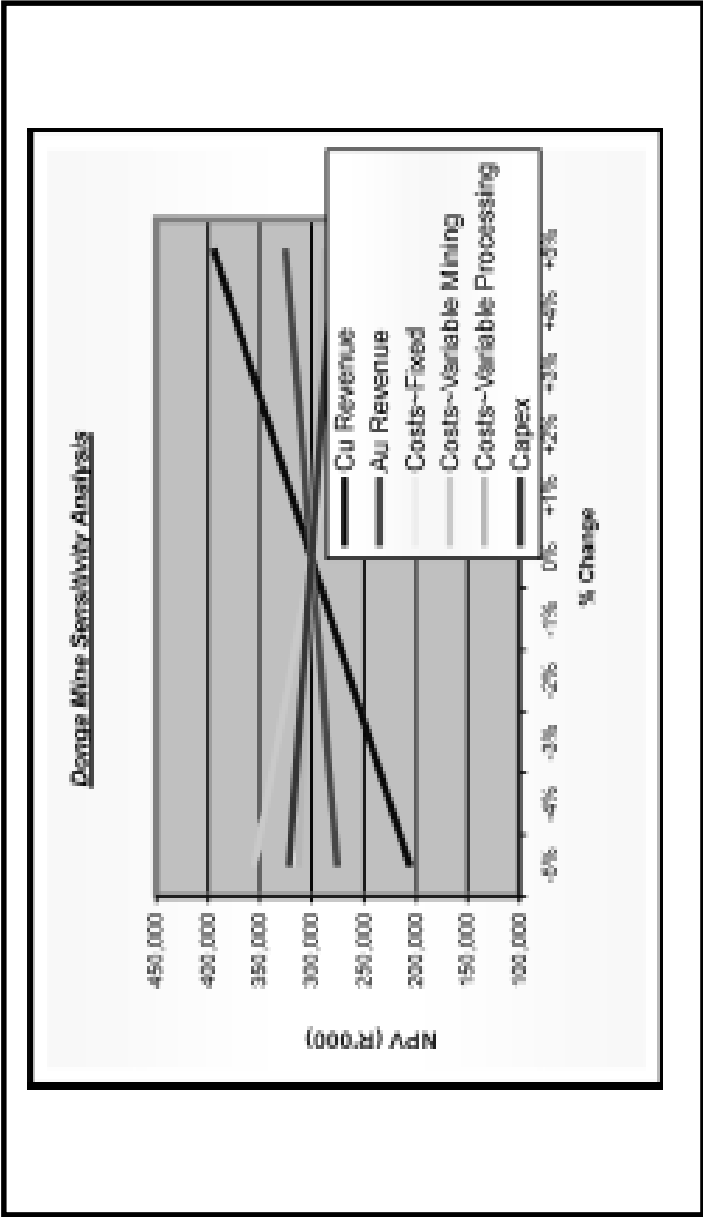


Figure 4
Sensitivity analysis

For example, the effect of changes in dilution was assessed on an operation, and the results are as shown in Figure 6.

In this instance, an increase in dilution from 10% to 30% has resulted in a decrease in NPV from \$32.84 million to \$20.50 million, representing a 37.6% reduction. This would translate into a commensurate drop in share book value, and a probably higher drop in market value.

This case is a massive mining example, where operations have frequently found that dilution rates in excess of 50% are not uncommon, sometimes against planned dilution of 10-15%.

The time and effort to establish effective management controls on these items would certainly have a very short payback, and have a significant effect on short-term payability and long-term value.

ADDING VALUE

The pictures painted above illustrate how value is influenced by managing and tracking key value drivers that lie in the area of MRM.

This, however, provides the base value for a mine or company, and allows, for example, the issue share price to be derived.

The real value of MRM is the degree to which MRM can improve value over and above this baseline.

To illustrate this, let us assume that a baseline Life of Mine plan has been generated. A cashflow analysis is done on the plan using a discount rate equal to the minimum acceptable rate of return to the debt financiers and equity holders, and the project delivers an NPV of \$20 million. The project has an acceptable IRR, and is given the go ahead.

The question is, will the shareholder be satisfied with his returns? This is an impossible question to answer because one does not know what the alternative returns may be, or how circumstances may change in the future. However, the project will deliver, if everything goes according to plan, his minimum expectation because the NPV is

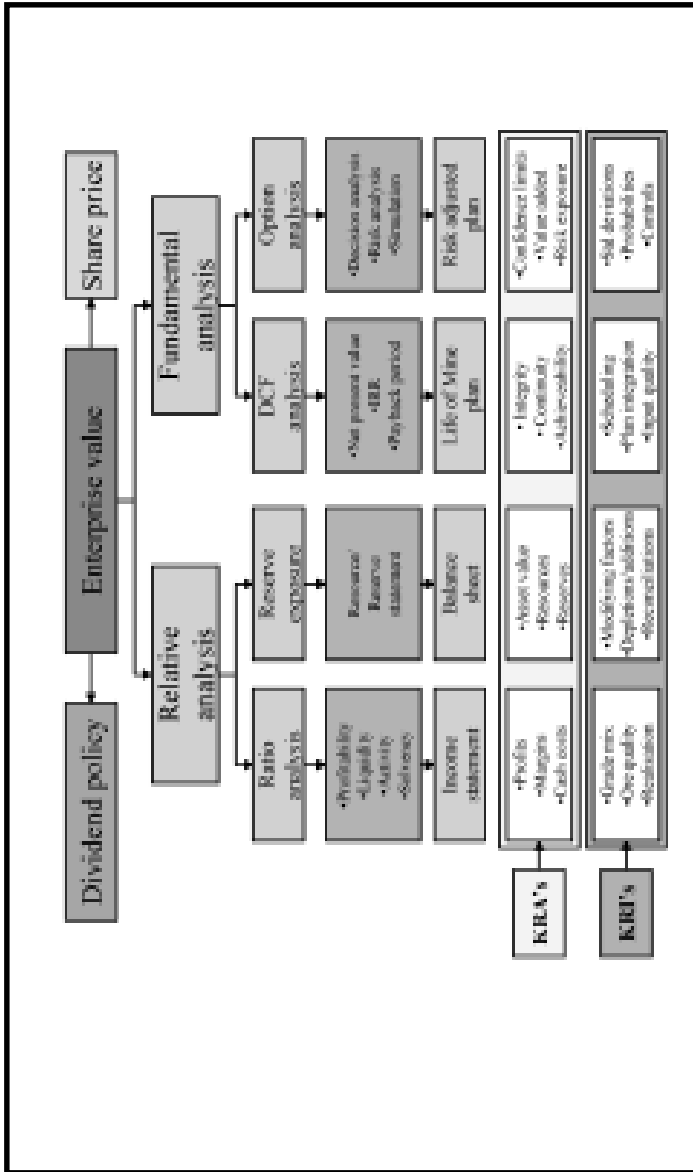


Figure 5
Audit trail of value through a mining company

positive when cashflow is discounted at the minimum return. Indeed, there is \$20 million available for distribution or reinvestment.

The real value however, will be realised when:

- Risk and uncertainty is minimised in the business;
- The base plan is optimised in order to exceed the base NPV;
- Free cash is generated, after investor expectations have been satisfied.

This is the key value of MRM: to add value and to minimise risk from the orebody. This is the basic premise of Economic Value Added, which is supported by the following statement by Peter Drucker who says: "Until a business returns a profit that is greater than its cost of capital, it operates at a loss. Never mind that it pays taxes as if it had a genuine profit. The enterprise still returns less to the economy than it devours in resources. Until then it does not create wealth : it destroys it."

Effective MRM, in creating added value, should focus on the following:

- Upgrading confidence by reducing risk in plan variables. This may require investment, in development or exploration, or in investigation into trends and cause and effect issues, resulting in process redesign;
- Risk reduction through quality assurance programmes, and the establishment of clear audit trails and reconciliations;
- Optimisation of the plan, through the constant evaluation of alternative scenarios and opportunities;
- Cutting out loss making activities and operations;
- Application of innovative designs, technologies and methods;
- Constant integration of value chain activities.

In the area of optimisation, examples of optimisation opportunities include:

- Optimising operating volume and grade;
- Optimising cutoff grade policy through understanding of cost/volume and grade/tonnage relationships;
- Optimising open pit design and planning, through optimal

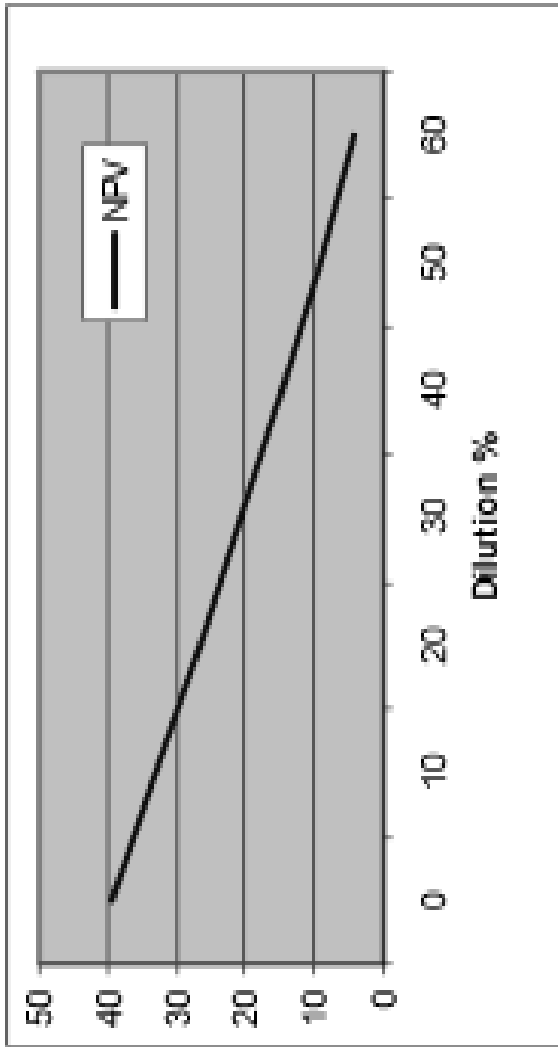


Figure 6
Effect of dilution on NPV

- stripping ratios and cutback sequences;
- Optimising grade profiles over the life of the mine;
- Optimising cutoff grade policy over the life of the mine;
- Optimising infrastructure planning and utilisation;
- Adjusting plans as circumstances change;
- Optimising stockpiling and distribution policies;
- Identifying and seizing market opportunities as they arise;
- Creating flexibility in the operation.

It is beyond the scope of this paper to describe all of these, but the following two real examples illustrate the potential of optimisation.

In the first example, a shaft of a gold mine, had been operating at its full capacity, mining a high channel width orebody. Grades were relatively low, but this was compensated by the fact that the high volume mining provided economy of scale benefits, and thus low operating costs.

However, global paylimit application, which was applicable at Company level, directed the shaft to mine low volume, at high grade.

An investigation of the operation revealed the true situation, through a careful analysis of cost/volume behaviour, using costs and cutoff grades applicable to the shaft itself. The effect is shown in Figures 7 and 8.

Figure 7 illustrates the true cost/volume behaviour for the shaft, which shows that although the margin is relatively low, optimal operating volume at existing gold prices, should be around 17 000 square meters per month. Of particular interest was the curve on the revenue line, which illustrates that this point is influenced by both revenue and cost, and that revenue does not improve at higher volume, because of a shortage of sustainable high-grade ore.

The grade/tonnage curve verified this. The unit cost and revenue graph (Figure 8) shows the same effect.

As the case was, the shaft was operating at less than 10 000 square meters per month, and operating at a loss. The decision to be taken by MRM in this case, having done the optimisation, was to decide

whether to operate at 17 000 square meters per month, at a small profit, or to mothball the operation until gold prices improved.

The second example was conducted on a larger scale, and centred around stope productivity improvement. In this case, stope productivity improvement brought about by a small unit cost reduction as a result of technology implementation, coupled with a marginal improvement in advance per blast, was used to assess the effect upon cutoff grade.

The effect of these improvements on cutoff grade was to effect a reduction of 10%, which, when applied to the grade/tonnage graph (Figure 9) resulted in an improvement in available resource above the cutoff grade of 17%.

In the case in point, this, if applied across the board to the company concerned, would realise sufficient payable resource to mine 180 000 tons per month for 12 years, equivalent to a new mine, which, in today's terms, would warrant investment of some R4 billion, delivering double digit returns.

These simple examples illustrate the dramatic effects that MRM optimisation can have on the business and the decision making process. The results add value, which can be described as free cashflow, where this generates cashflow over and above a base case plan. In other words Economic Value has been added.

VALUE ADDITION AND VALUE DESTRUCTION

The above examples have, hopefully illustrated the principle of adding value through effective MRM. One must also be aware of value destruction, whereby future value is destroyed, through indiscriminate cost cutting, or poor control of key value drivers.

The graph (Figure 10) shows trends for reef development, which show:

- An unacceptable degree of fluctuation on achievement of a key value driver (which in this case was critical)
- On average, a failure to meet or even plan to the level necessary

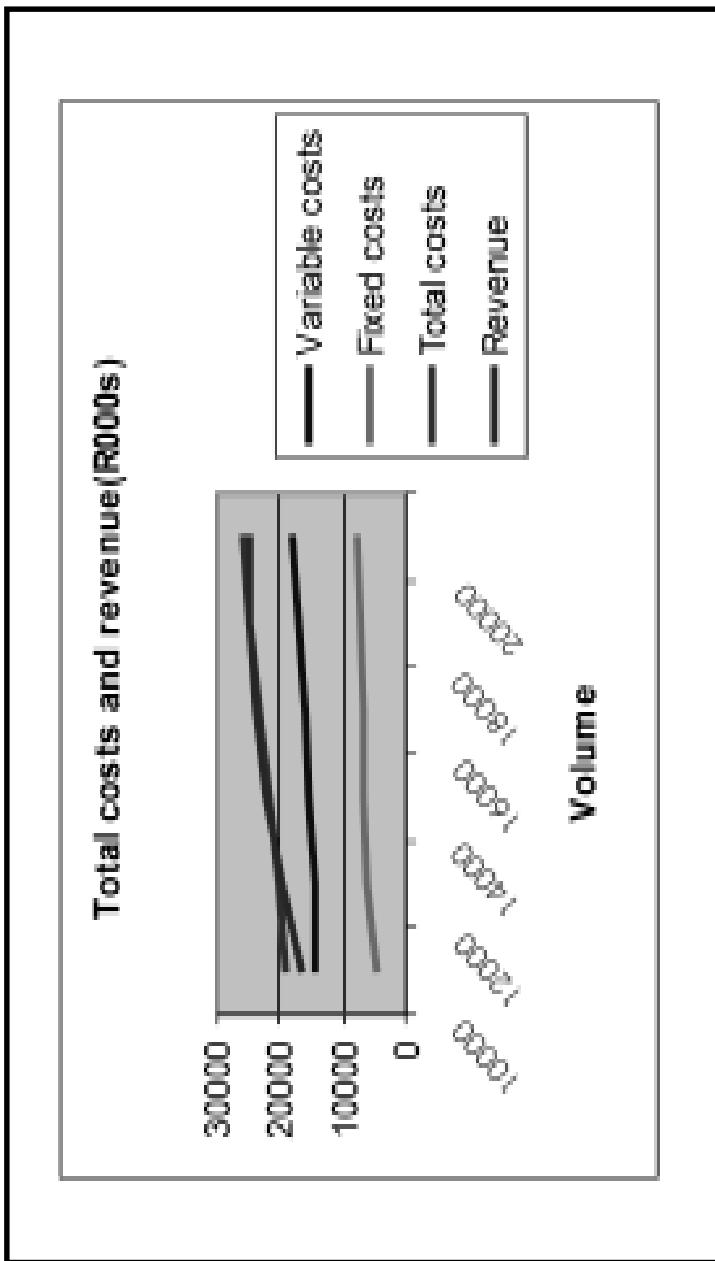


Figure 7
Cost/revenue/volume optimisation

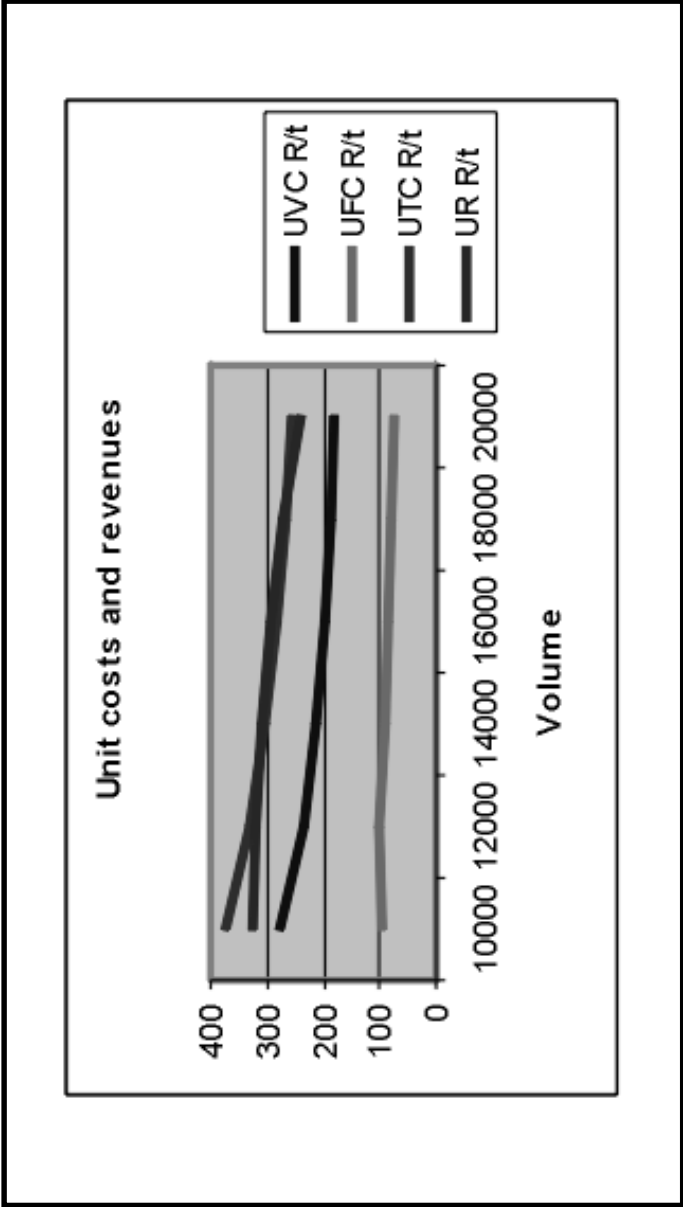


Figure 8
Unit cost/revenue/volume optimisation

to maintain mineral reserve at the current levels (which themselves were too low).

It is not difficult to see that in this case, value is being visibly destroyed. The consequence of all these observations is that the key value drivers, once identified, can be used as performance management criteria for Mine Management, on their Mineral Resource Management teams.

Achievement or non-achievement of these key value drivers, within acceptable limits of statistical tolerance, should be the criteria upon which MRM is measured and rewarded in the industry.

Every factor can be tracked right through to shareholder or enterprise value added or destroyed, and these should be used as the appraisal benchmarks for MRM.

In the final analysis, it is proposed that the true measure of success of MRM should be a ratio, which encapsulates all of these principles, namely the economic value ratio.

This ratio should be calculated as the ratio between NPV of the long-term plan and the amount of free cashflow generated per annum (the EVA cash).

Any change in the ratio year on year will be indicative of a shift in balance between the short term and long term value, and any value adding or value destroying activity being undertaken.

WHAT THE MANAGER MUST EXPECT FROM MRM

In summary, MRM should encompass the following key elements:

- Quality geological models and standards;
- Quality evaluation models and outputs;
- Resource and Reserve statements with clear audit trails and quality assurance;
- Reserves that are based on quality Life of Mine plans that reflect the value of the operation;

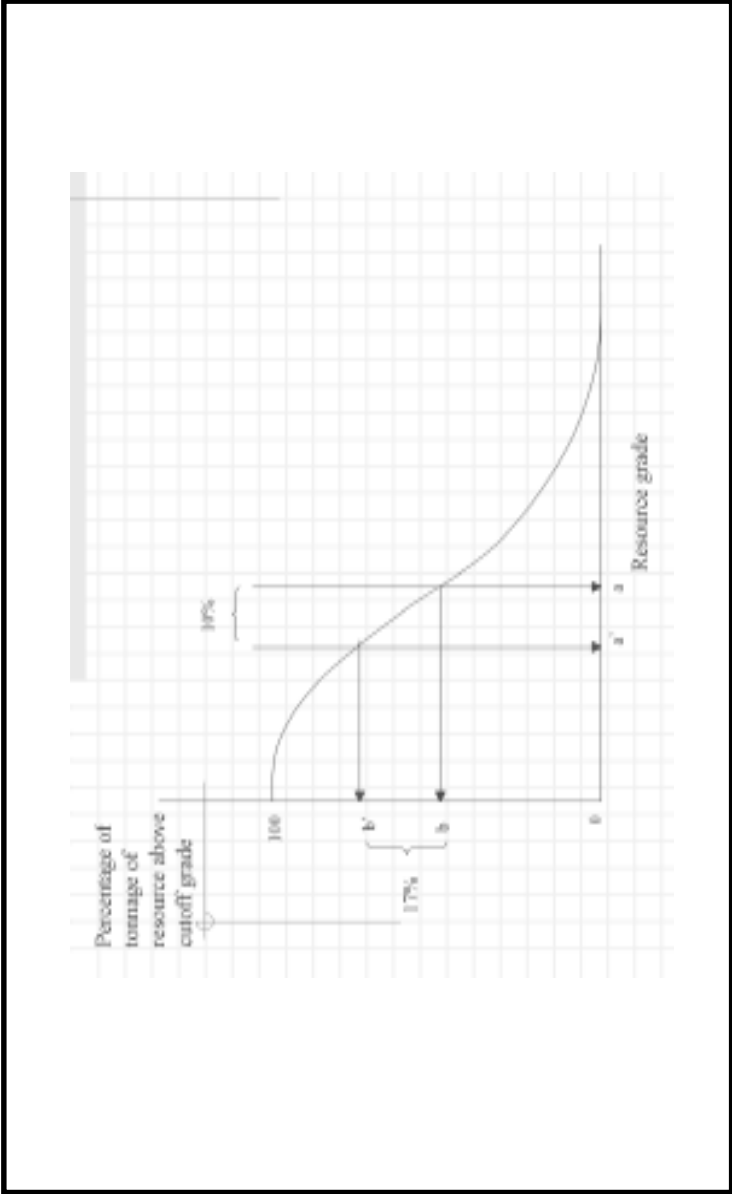


Figure 9
Optimisation of cutoff grade

- Integrated short and longer term plans;
- Detailed reconciliation and variance analysis on production compliance to plan;
- Management controls on key value drivers;
- Risk assessment and management on all MRM variables, culminating in confidence levels on plans and achievements;
- Quality control systems throughout the value chain;
- Continuous search for improvement through optimization;
- Value addition, measured through key value driver trend analysis;
- Competitive advantage.

There is, of course, always a word of caution. Many organisations have jumped into MRM, but have been disappointed not to have realised the benefits they expected.

Whilst there are many reasons for this, it is often the case that the base is not secure, in that basic geological, planning and survey standards are not in place, and input information is inadequate, insufficient or of poor quality.

There is no point whatsoever in implementing MRM if these bases are not sound. MRM relies on high quality geology, survey, assaying and planning as fundamental inputs. Sometimes the mistake is made that people in the MRM team become generalists, with the result that the base is lost. This must not happen.

REFERENCES

1. Booth R, Avoiding pitfalls in investment appraisal, Management Accounting, November 1999
2. Gitman LJ, Principles of managerial finance, 9th edition, Addison Wesley publishing, 2000
3. Macfarlane AS, A Code for the Valuation of Mining and Mineral Projects in South Africa, Australian Institute of Mining and Metallurgy, Brisbane, 2001

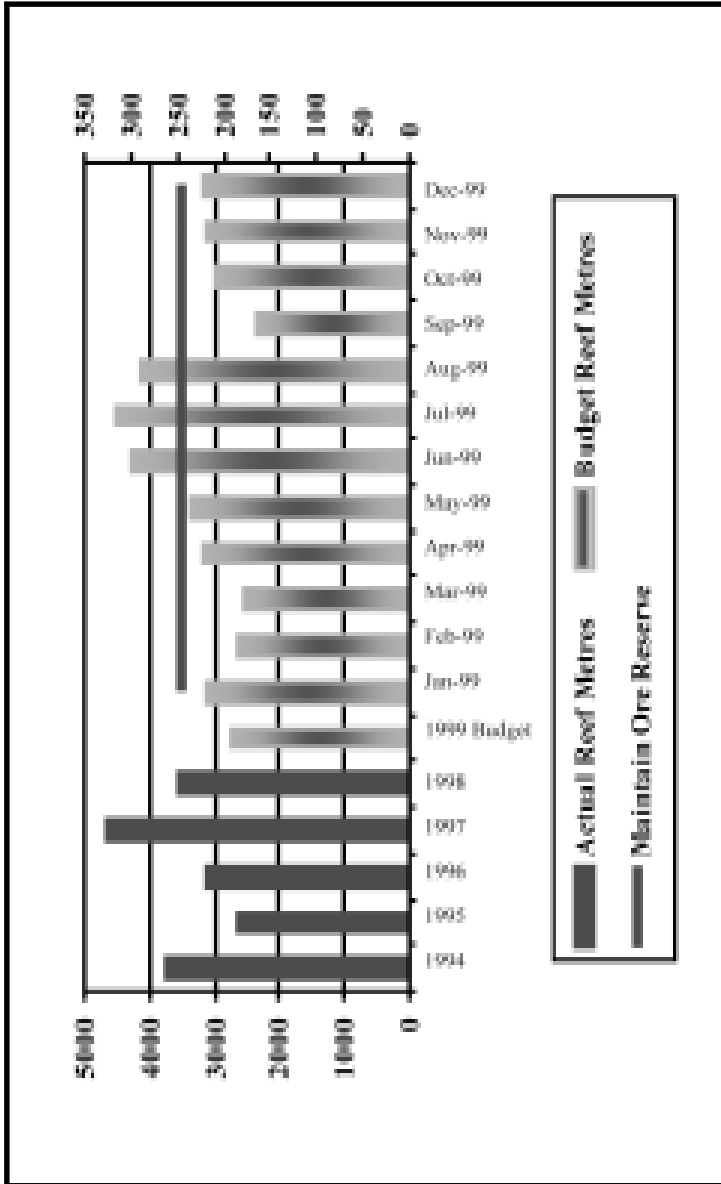


Figure 10
Example of value destruction

4. Macfarlane AS, Maximising shareholder wealth in mineral projects through Mineral Resource Management, SAIMM, Johannesburg 2000
5. Macfarlane AS, Mineral Resource Management and Economic Value Add, presentation to the Geological Society of South Africa, Johannesburg, 2001
6. SAIMM, The Samrec Code, Johannesburg 1998