The Inclusive Management of Operating Risk, Efficiency, and Organisation Dynamics at the Cosmo Howley Mine

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ABSTRACT

The typical management systems used to address the issue of operating risk centre around technologies that identify, analyse and evaluate the risk factors. Logical systems such as HAZOPs, Fault Tree Analyses, etc rely too heavily on technical considerations and process flow analysis.

However, several research projects, across industries and countries have clearly shown that up to 80% 'operating risk' is determined by the actions of workers, supervisors and managers. Yet, most of the focus of risk management is on the technical and procedural issues. This suggests that a significant imbalance exists in our management systems and that industries are unlikely to show significant improvement on current levels of safety performance.

Effective risk management must include the intangible elements of the organisation psychology towards risk. A practical and theoretically sound approach has been researched and developed in and for the mining industry. This paper the approach and methodologies applied in the Cosmos Howley Gold Mine in the northern Territory, where an inclusive approach to managing financial and operating risk was followed.

The Cosmos Howley Mine showed a dramatic reduction in its lost time injuries and improvement in financial indices - providing conclusive evidence of the link between management effectiveness, safety, and productivity. This 'triangle' has often been the subject of speculation theory. It is demonstrated in this paper how the management team of Cosmo Howley focused their practices and systems on the improvement of organizational dynamics, ensured tangible and clear focus on parameters of costs and safety and how the improvement process was managed.

It is concluded that the improvement process did not require a 'major re-engineering' of the organisation. The organisations culture changes that occurred were incremental, planned an effective. It entailed the implementation of sound risk management methodologies, and ensured that a significant emphasis was placed on an aspect that is defined as 'organisational dynamics.

INTRODUCTION

The Cosmos Howley Gold Mine was located 150 km south of Darwin in the Northern territory. The mine, owned by Dominion Mining Limited, commenced operations in 1989 and has produced in excess of 400 000 ounces. The mine operated on a small margin, with an average grade of 2.2 g/t Au. The implication of such tight margins is that operating risk may increase, where operating risk is defined as a decrease in the overall standards of safety, applied within the operation. A variety of possible reasons could cause management to:

- Limit expenditure on safety management systems;
- Limit expenditure on precautionary and preventative measures
- Purchase of less that optimal equipment; and limit the management time and effort expended on safety issues.
- The obvious challenge is to establish a cohesive and effective safety management approach, given the cost constraints of such an operation. Safety management systems are often, especially within Australia, provided through external consultants or sub-contracting specialists. Both avenues tend to be expensive options, which can strain the financial resources available.

A second issue is the proliferation of governmental requirements through occupational health and safety legislation, providing a myriad of compliance issues. Such issues often stifle the effectiveness of safety management in an environment where compliance is seen as a direct threat to financial viability.

THE MANAGEMENT OF OPERATING RISK

Risk management is a relatively young science, which, according to Doherty (1988), was only functionally defined in the late 1950s and early 1960s as a separate discipline.

Risk management technologies were mostly developed from administrative disciplines with in the management sciences, hence a high degree of recording, accounting, and control methodologies being employed as a means of reducing risk. The focus in risk management is also an analytical-technical one, identifying, analyzing and evaluating risk is a 'quantitative'

discipline. Techniques such as Hazard and Operability (HAZOP) analysis, the Management Oversights Risk tree (MORT) analysis, Failure Mode and Effect analysis (FMEA), Fault Tree Analysis, etc have been available for some time. The focus is on the physical risk associated with plant. Design operation, and ergonomics, with relatively little emphasis on the organizational issues such as worker-management interface. The associated safety science is similar in content and application. Recently, the safety management discipline has become one of compliance with legislative requirements and therefore, mainly, an administrative one.

It can be argued that progress in the management sciences has left the risk and safety management sciences far behind. Modern management textbook and management practices in industry abound with dynamic, flexible, and pro-active techniques and systems. However, most of the typical safety management systems still espoused by safety institutions date from the 1960s namely the so-called loss control approaches. These systems typically institute recording and controlling systems in the organisation, often at considerable cost, are rigid in sign and application, and demand action in areas that often make little real difference to the safety performance.

On the other hand, Total Quality Management or Continuous Improvement (TQM/CI) approaches have been able to improve operating efficiencies and product quality within many organisations. The use of more dynamic management techniques, while at the same time instilling a higher degree of discipline through statistical measurement, has been largely responsible for these improvements. However these approaches have not contributed significantly to the management of operating risk, despite the claim by many that safety is an integral part of the TQM/CI. The obvious fact is that accidents are not a continuous product of any system, and can therefore not be managed through the traditional tools of quality management that rely mostly on descriptive statistical and variation measurement.

More important, the dynamic organisational factors that 'produce' risk-taking behaviour in an organisation (described below) can generally not be addressed by the simplistic system analysis and improvement techniques available in the TQM/CI approaches.

Operating risk and its relationship to accident events, is according to Denton (1982) poorly quantified and therefore statistically weak data. Obviously, a more sophisticated and more predictive measurement of risks is necessary. This can be achieved by a quantitative assessment of risk-taking behaviour in an organisation.

Many industries, including the Australian mining industry, are experiencing a 'bottoming out' of injury frequencies, suggesting that safety management cannot improve significantly upon its current effects. The biggest risk in any organisation is in the actions of its employees and not in the risk associated with the physical factors such as equipment, physical environment, or plant design. Understanding, and managing, the psychological and sociological aspects of risk-taking behaviour provide the opportunity for a breakthrough in safety performances needed by industry today. The breakthrough can probably be achieved through the new science of risk psychology.

THE PYSCHOLOGY OF RISK

The psychology of risks is a much more complex subject than generally suggested in the safety management science. Early safety research simplified the behavioural causes of accidents to one of improper attitude, lack of knowledge or skill, physical unsuitability or improper environment. Within such a narrowly defined concept of the human factor in accidents, the accident prevention strategies were interpreted rigidly and simplistically by the exponents. The notion of Engineering, Education, and Enforcement (the traditional three E's of safety) still persists in modern safety management thinking. Yet, modern schools of thought state emphatically that education and enforcement are the least effective methods towards changing workers' behaviour. Several researchers, *inter alia,* Margolis and Kroes (1975) have pointed out that management's efforts to reduce this type of risk is futile if it is limited to the above-mentioned superficial focus on the accident phenomenon. It is postulated that there is a non-linear continuum in the accident chain of: Organizational Influences > Organizational Dynamics>Risk-taking Behaviour> Accidents. Each component in this chain must be addressed if the risk management effort is to be effective. Organisational influences Interventions by mangers should be aimed at the level of organizational influences on work behaviour. Researchers such as Souder (1988) have demonstrated the complexity of the phenomenon through a so-called catastrophe

theory of accidents, suggesting that the significant influences on the individual are:

- the physical work environment;
- the individual himself (psychological and perceptual);
- the immediate work environment of peers and supervision; and
- the management context

However, the issue is still more complex than that. These influences are still only descriptive and do not explain, in a scientific sense, the source of these influences.

Organisational Dynamics

The next level in the safety chain is that of organisational dynamics. Gibson, Ivancevich and Donnely (1982), illustrated this with the iceberg effect and postulated a visible part of the organisation, or the tip of the iceberg, and an invisible or informal component of organisations.

Risk Culture

The formal component of the organisation includes those elements that are publicly observable, rational, and oriented to structural considerations. This includes:

- job descriptions;
- departmentalisation bases;
- spans of control and hierarchical levels;
- missions, goals and objectives;
- policies and practices; and
- measurements.

Risk Climate

The informal component of the organisation includes elements that are hidden, affective, and oriented to social/psychological processes and behaviour:

- emergent power and influence patterns;
- individual perceptions of organisational competencies;
- patterns of interpersonal and inter-group relations, group sentiments and norms;
- perceptions of trust, openness and risk-taking behaviour;
- individual role perceptions, value orientations, emotional feelings, needs and desires; and
- affective relationships between managers and subordinates.

Risk motives

The above processes and influences interrelate and affect the individual in a complex and dynamic way. This is further interpreted by the individual within his own complex and dynamic psychology as risk motives. Measuring the risk in these circumstances is extremely difficult, yet safety practitioners still persist with superficial measurements and programs to address the safety problem, such as the procedures of accident investigation and analysis, which commonly describes simplistic casual chains of events.

It follows that the average safety professional, supervisor or manager could not be expected to even attempt interventions in these complex components of organisations. Even so-called Organisational Development (OD) specialists are mostly unable to affect changes other than in the visible component of the organisation, or with only *ad hoc* and superficial affects on the invisible component. Furthermore, the examples of OD interventions to address the issues of operating risk in an organisation are very few and far between.

The link between organisational influences (or upstream factors) and the end-point of physical exposure to risks and accidents (or downstream factors) is indirect, mostly unpredictable and extremely random. A mass of risky behaviours may occur before an incident may randomly occur. The focus on managing these downstream factors is mostly futile and very frustrating to a manager.

Figure 1 by Krause and Hadley (1990) describes the accident chain in the context of so-called 'upstream' (dynamics) and 'downstream' (exposure) factors.

Figure 1 - Upstream and downstream safety factors

THE Qmap MANAGEMENT MODEL AND RESEARCH

As mentioned earlier, risk management science continued to rely on outdated techniques and systems, while at the same time (during 1970s and 1980s) very significant research and development work on the relationship between organisational dynamics and productivity or efficiency took place. Research into the subject of organisational dynamics affecting risk is very scant. Risk in the mining environment received very little, if any, attention from behavioural scientists. This has resulted in a proliferation of loss control approaches to safety management in the mining industries of South Africa, USA, Canada, and Australia.

In 1986, one of the authors conducted research for one of the major mining corporations of South Africa into the psychology of safety and risks. This resulted in an approach towards risk management that was unique in its design and practical in its application (Pitzer, 1989).
While the new approach had to address the complexity of organisational dynamics, it also had to be practical enough to be understood and manageable by the average mining supervisor and manager. This was achieved through the implementation of so-called safety performance reviews. It entailed the measurement of the dynamics of the organisation through a unique electronic survey of employee perceptions, and then an extensive feedback and action design program by the management and other teams in the organisation.

This process was further researched and developed to include a more complete model of managerial effectiveness and introduced to industry in as the Qmap model and associated systems. Attached (Appendix I) is a set of dynamic factors that have been found to produce risk-avoiding (and productive) behaviour in organisations. These factors are measures of the fundamental dynamics that underlay excellence in an organisation and they are categorised as factors of Management Credibility, the Risk Culture, the Risk Climate, and Risk Motives in the organisation.

THE COSMO HOWLEY CASE

The survey of organisational dynamics

A survey on these risk factors was conducted at the Cosmo Howley Mine during September 1992 using the abovementioned electronic survey method. This method ensures that the responses of employees are totally anonymous and not affected by the numerous potentially detrimental influences of perception surveys, such as response patterns, so-called halo effects or other deficiencies. Comprehensive series of profiles of the organisation and all its sub-sections were developed and analysed. It provided an almost quantitative picture of all those organisational dynamics associated with risk-taking behaviour and an accurate diagnosis of the organisation from which management could institute and direct corrective actions.

The major finding of this first survey was that the following factors were perceived to be negative and detrimental to the management of risks:

- management's credibility was perceived to be negative;
- employees perceived specific goals for risk reduction and production unclear;
- rewards (financial and otherwise) were perceived as inadequate;
- communication from management was perceived as insufficient or inadequate; and
- employees did not feel valued for their contributions.

Several other issues such as Team Spirit were measured as positive amongst employees.

However, this first survey showed a remarkable degree of indifference. Most employees were apathetic to organisational issues at the mine, showing overall neutrality towards many of the categories surveyed.

The management response and action design

The survey findings were presented to management during a structured action meeting. The survey findings were interpreted by one of the authors, while the management team themselves then designed appropriate responses to the findings. Over a period of several months the following actions were taken:

- Employees were given feedback of the findings during November 1992 and their inputs into possible improvement actions were obtained.
- Several channels for active involvement of employees, at all levels, were introduced and a
  system of rewards for contributions was introduced.
- The most notable system was the introduction of workshop type activity during February 1993, where employees were invited to inspect any work site and suggest any form of improvement. The focus of these workshops was on risks and wastes in the work place and conducted at six weekly intervals. These workshops introduced the basic steps of risk management into the management of the mine, namely risk/waste identification, risk/waste evaluation and risk/waste handling, but at such a level that every employee could contribute to the management process.

Eventually a complete cycle of risk identification and risk reduction existed in the organisation, while at the same time the fundamental organisation dynamics were improved and pro-actively managed. This also required a proper administration system that was developed and introduced by the administration superintendent. It entailed the detailed description of all

risk/waste reducing activities in progress in the organisation and the stage of completion, ensuring that the control over these activities was exact and complete.

The measurement of management effectiveness is not straightforward, especially on a gold mine where short-term changes in mined grade can influence the short-term financial performance of the operation. This can occur even when management is being 'effective'. To overcome this difficulty (and in fact to allow comparisons between the different mine sites), a measurement model for improvement in operational efficiencies and safety performances was developed for the mine. The measurement was of a very rigorous design, with four perspectives on each measurable operating parameter, namely accuracy of targeting, improvement in this accuracy, improvement in targets and improvements in actual performance. It is a very sensitive measure and requires effective management to achieve optimal performance on these measurements. The basic principle behind the measure is that:

- An effectively managed operation will perform closely to its stated targets; and
- Actual improvements can be driven by setting more stringent targets.

(The scope and impact of this new approach to performance analysis is being further developed and potentially a subject of a separate research paper).

The parameters shown in Table 1 were some of the measured variables of the model. It is the objective of the measurement model to both drive and measure management effectiveness. The parameters were selected to ensure that the measured improvement was over factors that were under management control. However, the reality of a mining operation is that a variable such as mineral grade impacts directly on overall performance, while management only has partial control over it, through grade dilution minimisation.

Table 1
Operational performance results

Parameter (Units)	Period 1 Mean Sep 92-Feb 93	Period 2 Mean Mar 93-Sep 93	Change (percent)	Direction of Change Sep 92-Sep 93
Dollar/BCM ($/m3)	5.11	4.08	.20	improve
Mixed grade (g/t)	2.29	2.30	+.04	no change
Dollar/gram (mine) ($/g)	7.67	9.08	+18.4	deteriorate
Dollar/tonne Milled ($/t)	11.5	9.72	-15.54	Improve
Tail grade (g/t)	0.29	0.26	-10.3	Improve
Dollar/gram (plant) ($/g)	5.32	4.84	-9.0	improve

Table 2
Safety performance results

Parameter	Period 1 Mean Sep 92-Feb 93	Period 2 Mean Mar 93-Sep 93	Change (percent)	Direction of Change Sep 92-Sep 93
LTI frequency rate	25.23	9.69	-61.6	Improve

The results

Operational performance results

Tables 1 and 2 summarise the change in operational performance and safety performance for the 12-month period. The following actual improvements occurred in the indices of efficiency for operational outputs. Measurements are in two periods, namely before any interventions (Period 1) and approximately six months after the interventions

were introduced (Period 2). Each period measures mean performance over the preceding six months.

Discussion of operational performance results

The following points need to be recognized when considering the information in Table 1.

- The most significant performance improvements were achieved on the measures of dollars/BCM and dollar/tonne milled. These two measures are also the most direct measurements of a mine's operating efficiency. The other measures are a function of the head grade, which remained very constant throughout the period under review. The tail grade (residual grade in the process tailings) is a function of the metallurgical efficiency of the plant and has shown improvement.
- Most of the management initiatives were introduced during and after February 1993, the end of period 1, and it was only after this period that the effects became visible. The improvements in the second, and over the last 12 months, are significantly positive, an evident from Table 1.
- The significant deterioration in dollar/gram (mined) is a result of a diminishing orebody at the mine's main pit. In the period under discussion, the strip ratio (ratio of ore mined to waste mined) changed with 55.3% from 6.82 during the first period, to 10.59 in the second period, explaining the deteriorating index of dollar/gram (mined).

- The improvements in tail grade reflect the effort by the processing staff to continuously assess and improve the operational performance of the plant. During this period, no significant technical changes in plant layout were made, other than what was introduced through the operators' and supervisors' contributions. Most effort however went into the cost expenditure on the process.

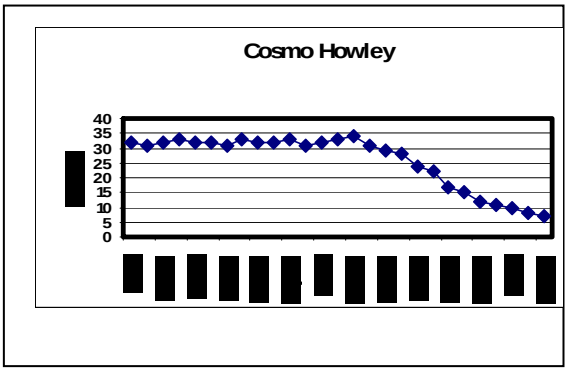
Safety performance result

The safety performance is measured by the Lost Time Injury Frequency Rate (LTIFR), which is expressed as the number of lost time injuries per million man-hours. As a guideline, the industry average for this index in 1992/3 was approximately 18 for open pit gold mines in Western Australia.

Discussion of safety performance results

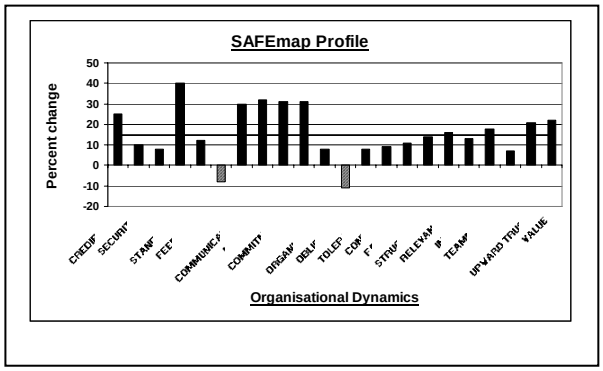
- The safety performance of the mine improved substantially, by 61.6% over the 12-month period.
- From Figure 2 it can be noted that the mean LTIFR in period 1 was considerably worse than the industry average, while in period 2 considerably better. During the same period, the mine also recorded its highest number of accident free days of 221.
- The graph on the LTIFR improvements shows four distinct phases, namely a period of no change, immediately prior to the survey in August/September 1992. An immediate, slight improvement occurred. After October 1992, a further, more dramatic improvement occurred following the feedback to employees and introduction of improvements from the management. With the commencement of the Safety and Improvement workshops in January 1993, a further period of sustained improvement follows. It suggests that the actions of management resulted in visible and direct impact on the safety performance of the mine.

Figure 2: Safety Improvements at Cosmo Howley



A second survey of organisational dynamics was conducted at Cosmo, 12 months after the first one. The significant improvements on these factors are depicted at Figure 3.

Figure 3: Improvement in Attitude Survey



- As evident from Fiigure 3, the overall improvements on the factors of organisational dynamics improved dramatically.
- Only two factors deteriorated namely Rewards and Obligation. The more negative perception of Rewards can be explained by the fact that an expected salary increase in December/January did not materialize. The deterioration on the issue of Obligation can probably be explained by the fact that the management process at Cosmo Howley ensured strong direction and controls by management. Under these circumstances, employees would experience a diminished sense of responsibility for the processes of improvement in the organisation. This does not imply that employees were not involved in the processes. Several channels for participation were established and positively perceived as evidenced by the positive trend on 'Structures'.
  The mining contractors were included in this process of involvement and their employees shared in rewards from the company even if the savings and improvements only affected contractor's activities.
- The most noticeable improvements of employee perceptions were on the factors of Management Credibility, Standards, Communication, Management's Commitment to Safety, Balance Between Safety and production, Structures of Employees Involvement, Relevance and recognition Individual Job Inputs, Sense of Team Spirit, Upward Trust in Direct Supervision and (management's) Value of Employees' Well-being. An overall significant improvement was achieved. The improvements were more significant in the categories of Risk Motives, suggesting that the improvements in Risk Culture and in Risk Climate have a compounding influence on Risk Motives. Such dramatic improvements in Organizational Dynamics are rare occurrences and must be attributed to a sustained and excellent effort from Cosmo Howley's management team.

CONCLUSIONS

The remarkable feature of the performance improvements that occurred was the congruence between measures of operational efficiency, the trends in safety performance, and the improvements in the measured organisational dynamics. Clearly, the highly significant improvements in all three measures occurred during the same periods of time and the possibility that this occurred as a result of chance can be confidently discounted. The very high levels of statistical significance for improvement found in this study are relatively rare in the real production environment.

A key to establishing the correlation between efficiency, safety, and organisational dynamics has been the development of new measures of these parameters. While the LTIFR as a measure of safety is a well known measure, the measurement of efficiency and organisational dynamics are unique in design and application.

There is a clear case for a management science of so-called 'psychology of risks'. It is because of a lack of research work, quality and quantity, in this field that such little progress has been made in risk management overall. The risk management science seems to have stagnated while other associated sciences advanced significantly. This is clear from the fact that most of the risk management techniques are outdated, while much of the behavioural science's research was not incorporated into risk management. The Cosmo Howley case contributes to the research on this topic.

The Cosmo Howley case is an exceptional example of the improvement in organisational dynamics and its resultant effect on the outputs of the organisation. The specific case provided a unique opportunity to study the effects of the mentioned interventions and approaches, within a strong experimental design.

It can finally be concluded that the management of risk needs to be seen as an inclusive activity, within the bounds of basic operations management - and not as one that interests only the safety or risk management practitioner.

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REFERENCES

Denton, D.K. 1982. Company, New York). *In Safety Management: Improving Performance* (McGraw-Hill Book

Doherty, N.A. 1988., UK. *Handbook of Risk Management* (Kluwer Publishing Limited: Bradford-on-Avon

Gibson, J.L. Ivancevich, J.M. and Donnely, J.H. 1982. *Organisations: Behaviour, Structure, Processes* (Fourth Edition) (Business Publications, Inc, Piano: Texas)

Margoliss, B.L. and Kroes, W.H. 1975. *The Human Side of Accident Prevention. Psychological Concepts and Principles which bear on Industrial Safety* (Charles C Thomas Publisher: Springfield, USA)

Pitzer, C.J. 1989. The Application of Risk Management Concepts in the Mining Industry of South Africa. MBA Dissertation (Unpublished) University of Stellenbosch Business School South Africa.

Souder, W.E. 1988. *A Catastrophe Theory Model for Simulating Behavioural Accidents,* Bureau of Mines IC/9178. United States Department of the Interior, United States of America.

Appendix 1

CATEGORY	POSITIVE PERCEPTION	NEGATIVE PERCEPTION
CREDIBILITY	Management is trustworthy and credible	Management lacks credibility
SECURITY	The company's future is seen as secure	The company's future is doubtful
GOALS	Clear goals/targets in their jobs	Goals/targets are vague or ambiguous
STANDARDS	Standards/rules are viewed positively	Rules are viewed as excessive and wasteful
FEEDBACK	Good performance is noticed	Good performance is largely ignored
REWARDS	Financial rewards are adequate	Rewards are inadequate and not equitable
COMMUNICATION	Communication is Clear and adequately regular	Communication is inadequate and confusing
MOBILITY	Good opportunities for individual to advance	Opportunities to advance are lacking
COMMITMENT	Management is seen as strongly committed to safety/quality	Management is seen as lacking clear commitment to safety and quality
BALANCE	A balance between quality/safety and production exist	Production is at the cost of safety and quality
ORGANISATION	Workplaces and jobs are well organised	Poor organisation of work places and jobs
OBLIGATION	Employees feel responsible for quality/safety	Responsibility is viewed as someone else's
TOLERANCE	Supervisors tolerate small mistakes	Intolerance for small mistakes exists
CONFLICT	Little conflict between departments	Tension between departments exist
FATALISM	Accidents are mostly preventable	Accidents are largely inevitable/unavoidable
STRUCTURES	Supervisors listen to/accept suggestions	Supervisors disregard contributions
RELEVANCE	Inputs are recognised	Supervisors fail to recognise inputs
IMPACT	Supervisors acknowledge importance of employees	Supervisors disregard importance of employees' jobs
TEAMNESS	A positive spirit exists in work teams	A negative spirit exists in work teams
LOYALTY	Employees feel loyal towards the company	Employees show little loyalty
UPWARD TRUST	Supervisors are trustworthy and viewed as credible	Supervisors are not trusted
VALUE	The company is perceived as genuinely caring about employees	The company is viewed as not caring about employees