Risk Management Integration and Decision Making in the Minerals Industry

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Abstract

Decision making theory offers a new way of thinking about managing risk, especially if the gal is to effectively integrate risk management into the operation. If we agree that all risks are assumed in the decisions we make, than it becomes important to identify those decisions where the potential risk outcomes can be the greatest and make those decisions with greater care. This paper suggests that identification of key decision points in the management system is the route to effectively integrating risk management into the mine site. New practical theory about professional decision making is included to link the issue of decisions and risk. The theory differentiates between strategic, tactical and operational decisions in an organisation. An analysis of 27 major mining losses is used to illustrate the theory. This approach allows for discussion of the need to integrate risk analysis approaches into key strategic decisions for optimal reduction of risks. Finally a basic process for effectively integrating risk management into a mining operation is offered. It involves defining management and engineering tasks, identifying key decision points and defining the concepts, methods and logistics for risk analysis inclusion in the existing tasks.

Introduction

Integrated Risk Management involves carefully deducing the most effective areas for applying risk management based on the priority business outcomes and potential consequences of failures. The colloquialism most commonly quoted to describe successfully integrated risk management is “making it the way we do business”.

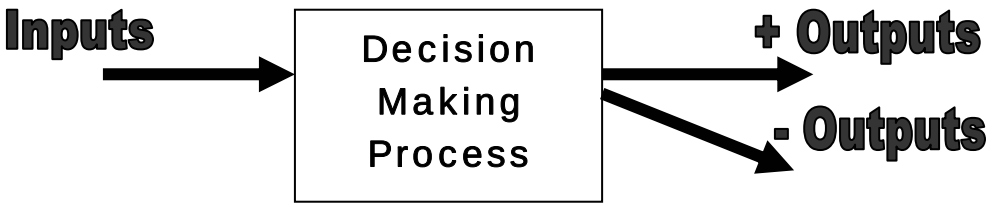
The process of designing and initiating an effective Integrated Risk Management approach may initially appear difficult. Finding the key points where risk should be managed is often seen to range from opportunities in day-to-day operations to board level activities.

For those who wish to investigate Integrated Risk Management, it might be helpful to examine some of the essential information offered by basic decision making and error theory.

Decision Making

Firstly, all significant risks are assumed as a result of decisions, either by the absence of a needed decision (an omission) or by an incorrect decision (an oversight).

The basic process model can help illustrate decisions.



The “Inputs” to the decision process may be the stated need to decide, the competency of the decision maker, the information being considered in the decision, etc. The “+ Outputs” of the decision process are, of course, the successful outcomes. The “- Outputs” of a decision might be divided into two stages.

The first stage "- Outputs" of a decision is a risk, a potential unwanted event(s) with probability and consequence. The second stage is the loss. The risk manifests itself in an event with a specific loss consequence.

There is always a negative potential outcome in a decision process. Every significant decision we make each day of our life could have negative consequences. The consequences could be minor, such as a few lost seconds of time delay, or they could involve life and limb.

The potential negative consequences of the decision can be used to identify its criticality.
Using this approach we can conclude that Risk Management is all about making good decisions, especially when potential negative consequences are high.

What is a decision?

According to Skinner (1999), a decision is a conscious, irrevocable allocation of resources with the purpose of achieving a desired objective. The resources could be financial, equipment, human or, in minor decisions, personal physical energy, for example, to cross the street.

It is apparent that we make many different types of decisions. Some are as common as crossing a busy street. Others might be rare and quite complex such as starting a new business. We may even perceive that we sometimes make decisions with minimal conscious thought, triggering behaviour based on specific external signals rather than after deliberate conscious considerations. An example of this may be pulling out from a stop sign while driving, often done while carrying on a conversation or listening to the radio.

Van der Molen and Bötticher (1988) are researchers in the area of driving behaviour. They have developed a generic model that suggests decisions can be divided into 3 types; operational, tactical and strategic.

Strategic decisions are those formal, planned exercises where we often go through a step-by-step type of process gathering relevant information, considering options, doing analysis and deriving a conclusion about the specific action. In the minerals industry we make strategic decisions in areas such as mine planning and equipment acquisition. As such these decisions are common in the management and engineering activities of the minerals industry. Formal, documented risk analysis may be a step in the strategic decision making process.

Tactical decisions are informal, timely exercises where judgement, often against pre-established decision rules, dictates the outcome. The decision rules may have actually been determined as part of an earlier strategic decision process. Where decision rules are not available tactical decisions may involve a conscious quick consideration of pros and cons. We all make many tactical decisions in an average day. In the minerals industry any task where an operator or supervisor must make a conscious decision before proceeding could involve a tactical decision. Many mines teach their personnel to do mental, informal risk analysis or hazard identification to assist in tactical decisions making.

Operational decisions involve a process where there is minimal conscious input to the outcome. The decision is made but is virtually an automatic response to some perceived signal. For example, we may learn a new task such as driving by making very conscious tactical decisions about controls like the accelerator and clutch, deliberately thinking when to push and when to release the pedals. Most of us probably experienced the missed gear or the stuttering starts while we learned to drive. Today we have operationalised the vast majority of our driving tasks. We usually don't think significantly about changing gears when we drive a manual transmission car. In the minerals industry machine control or other common tasks may be done by personnel following operational decision making. In other words, tasks are undertaken with little or no thought of pros and cons. Most common tasks we undertake each day will most likely be primarily driven by this type of almost automatic decision making. Even bad practices, if common and well practiced by the operator, may be operationalised.

Operational decision making has no risk analysis phase, formal or informal. If the common, basic task has been learned or operationalised without consideration of inherent hazards, risk may be run each time it is undertaken without any awareness of their presence. For example, if we learn to tie our danger tags in incorrect locations and we practice that behaviour for a long period without intervention, we may never consciously consider the consequences of this bad practice. Unsafe operational decisions are difficult to influence or change.

Another more common example is speeding. Most of us drive at or close to 10 % over the speed limit. We have probably driven that way for many years. Unless reminded of the consequences by external sources we would most likely not consider the practice to be unsafe. In other words we don't decide to speed each time we get in the car. We run risks based on based well learned task behaviour rather than take risks by choice.

Decision Making in Major Minerals Industry Losses

Past major accidents offer us an opportunity to apply the Van der Molen and Bötticher model. Following are three examples from accidents investigated by the author. The aforementioned decision models were used to identify and categorise assumed decisions that lead to significant unwanted behaviours.

Table 1. - Example Major Mining Events with Basic Decision Analysis

Loc.	Event	Out-come	Operational	Tactical	Strategic
Quarry	electric shock and fall from pole	1 dead	Decision by victim to grab wires on top of pole to remove them.	Decision to do work without checking isolation by supervisor	NA
UG Coal Mine	roof fall during extracting in old workings	3 dead	Decisions about amount of coal taken from pillars by continuous miner operator	Decision to remove parts of various pillars in old workings by deputy	Decisions about use of extraction plan for old workings by mine management
UG Metal Mine	Mechanical impact from material conveying apparatus	1 dead	Decision to check / inspect conveyor by victim	NA	Decisions to install some machine guarding after a study

In the first example a young apprentice electrician died from fall related injuries when an electric shock knocked him off a ladder on a pole in a small quarry. The task involved removing wires from the top of the pole. The electrician / supervisor assumed the power was isolated on the site due to his observation of persons performing maintenance work on other electrically powered equipment on the site.

The victim's decision to do the wire removal task could be considered an operational decision. Though he was an apprentice, the decision to do the task and grab the wires most likely involved little conscious thought. In fact the victim was probably concentrating on his previously stated concerns about working off ladders. The supervisor made an obvious tactical decision, he observed and interpreted information and arrived at an unfortunate conclusion. No strategic decisions were apparent major contributors to this fatality.

The other examples involve a major roof fall in old workings of a coal mine during pillar extraction mining and a fatal accident when a person was struck by materials handling equipment after placing his head in a pinch point.

The former offers examples of all 3 types of decisions. The latter shows a possible operational or almost unconscious / automatic decision to check a conveyor with strategic decisions upstream from the event.

Of course understanding the type of decision that contributed to the accident can help us identify future actions to avoid further related losses. The improvement methods vary with the decision type.

Strategic decision issues in an accident could be addressed by improving the relevant management or engineering activity. This might include more systematic planning, execution or monitoring systems.

Tactical decision issues in an accident usually indicated an issue with availability, understanding or adherence to decision rules or guidelines. Note that useful decision rules for tactical decisions often are derived through effective strategic decision making processes.

Operational decision issues are the hardest to address. Changing the operational decision basis for common task behaviour can be difficult. If changes in behaviour initiated by an operational decision are required, the behaviour must often be relearned. This may not be as easy as it sounds. Try relearning to drive at or under the speed limit on the highway.

Integrated Risk Management is mainly concerned with strategic decisions. If we expand the above sample we can examine the degree to which strategic decisions are relevant to major unwanted mining events.

The following 27 serious unwanted events had formal investigations where the author was involved. All but one occurred in Australia.

Table 2. - Sample of 27 Major Minerals Industry Incidents or Accidents

	Events
1	Electric shock and fall from pole in quarry
2	Chock leg hydraulic pressure release in longwall mining
3	Vehicle collision on surface mine haul road ramp
4	Roof fall while inspecting roof in pillar extraction operation
5	Truck runaway into shovel due to park brake problem
6	Crush of vehicle operator into rib
7	Rock fall crush from ore pass
8	Impact crush from material conveying apparatus
9	Person in ball mill when operated
10	Fall into large storage tank from roof
11	Fixed foam fire suppression cylinder pressure release
12	Permanent disability due to inadvertent conveyor movement
13	Continuous miner operator outburst fatality
14	Tailgate drive fire incident in longwall mine
15	Caught in longwall crusher
16	Washery fire due to oxyacetylene cutting problem
17	Spontaneous combustion event in underground mine
18	Shuttle car tyre rim release due to incorrect part
19	Impact injury due to flying coal from continuous miner tail
20	Dozer hit by dragline during relocation
21	Accumulator pressure release during inspection for leaks on vehicle
22	Isolation methods problem causes person to be caught by miner head
23	Conveyance failure due to impact of falling loco in shaft
24	Triple fatality outburst in panel
25	Rib spall while bolting off a continuous miner
26	Roof fall during extracting in old workings
27	Air pressure release from major pillar collapse

A review of the decisions related to the above 27 events yielded the following frequency table. There were multiple relevant decisions in each event. In 7 of the 27 events, it was difficult to determine whether the identified unwanted decision was operational or tactical. The most likely category according to investigation information was selected for the following analysis.

Table 3. - Decision Type Frequency from sample of 27 Events

Operational	Tactical	Strategic
20	14	24

If this sample is representative of major minerals industry losses, it indicates that operational decision issues are indeed common, in fact as common as strategic decision issues.

The finding that operational decisions are contributors to major accidents indicates that risk running, assuming risk in behaviours without conscious thought, is common. Risk taking where there is conscious consideration before behaviour would be part of the tactical decision area. The implications of this finding to risk management include the need to recognise that risk running is an important issue. Behaviour and culture management approaches in our operations must consider this relatively automatic process which may not be effectively modified by hazard awareness or motivational programs.

The many strategic decision contributors clearly indicate that decisions by managers and engineers are common contributors to accidents. Strategic decisions in the 27 example events include decisions to;

- proceed with mining without required drilling information,
- not resolve past problems with poor equipment performance,
- utilise control room operators for welding / cutting activities ,
- locate a ventilation shaft location where air would be pulled through the goaf,
- assemble heavy vehicle wheels with limited parts controls,
- move the dragline with reduced manning and inadequate preparation,
- maintain vehicles exposed to water acidity effects,
- design an isolation system on equipment making routine shift maintenance tedious,
- design, modify and inspect a potentially high risk area such as a shaft station,
- use high methane outburst mining methods in a high CO2 area,
- communicate / confirm key info with unreliable methods,
- extract old workings with no survey and not using the extraction plan,
- change a key hazard control in a specific mining method,
- change the installation location for the longwall,
- construct a haulage ramp different from the mine plan,
- continue mining despite exposure to windblast from hung up roof,
- modify a truck park brake / access stairs relay switch,
- construct a manual control system and operator position so visibility was limited,
- use unreliable means to identify ore pass locations,
- make modifications in some but not all areas after a guarding study,
- construct a piece of mining equipment without considering past risk issues,
- modify methods of building a storage tank top,
- undertake a new cylinder charging task with minor review, and
- design error provocative, manual operation switches on equipment.

As the example list illustrates the minerals industry makes strategic decisions in many areas that are implicated in major losses.

Strategic Decisions and Mine Management Activities

It has been suggested that mine management systems involve several main activities. The table below lists those activity areas and the distribution of strategic decision issues from the sample of 27.

Table 4. - Breakdown of Decision Locations from Sample of 27 Events

	Management Activity Area	**Number of Strategic Decisions**
(a)	Mine Planning	7
(b)	Ground Control	2
(c)	Ventilation	1
(d)	Communications	1
(e)	Purchasing / Supply	4
(f)	Transportation	2
(g)	Maintenance and Engineering	7
(h)	Administration	0
(i)	Human Resources	1
(j)	Emergency Response.	0

This table returns us to the initial discussion about Integrated Risk Management. If Integrated Risk Management involves deducing effective areas for applying risk management based on the priority business outcomes and potential consequences of failures, than the information illustrated in the above table shows the priority management activities for reducing inadequate strategic decisions. The data indicates, for our sample of 27, that improvement of Mine Planning, and Maintenance and Engineering could have major impact on these types of events. In both cases it would be reasonable to suggest that a requirement for risk analysis should be included in these activities, especially when the outcome could be major.

Of course using a sample of 27 past events is not ideal for developing an Integrated Risk Management approach for a minerals site. We need to be more pro-active, thinking about the needs of our specific site.

A basic process can be used to define and start an Integrated Risk Management System

1. **Identify the management activity areas at the site**. Consider the list in Table 4 and expand / modify so that the list includes any areas of management activity that occur at the mine. Contractor Management or Construction may also be included in some cases for example.

2. **List the specific tasks that are undertaken in each area.** Tasks are the specific work that is required in each management activity. For example in mine planning there may be long, moderate and short term planning in several areas of the mine.

3. **List the major decision points in each task**. Think about the tasks and note any major decisions in the task. Look for decisions that significantly affect resources such as people, materials and equipment, or the work environment such as transportation, ventilation, ground control, major hazard control, etc.

4. **For each decision point identify the frequency of the decision and the potential negative consequences of a poor decision.** The frequency and the consequence can be combined to identify the decision risk. Obviously frequent decisions that could, if inadequately done, lead to major negative consequences are the priority.

5. **For the highest frequency and consequence decisions, decide on a method of analysing risk** to assist in the decision making process. The method must suit the type of decision so varied approaches should be considered. The method may even involve checklists to prompt thinking about relevant areas.

6. **Draft a management protocol for the activity**, once the highest frequency and consequence decisions have been discussed, that includes a requirement for the specific risk analysis step. A management protocol might be written like a guideline, outlining the way the management activity or task is to be done, including Objective, Procedure, Accountabilities, etc.

7. **Implement the new protocol.** Introduce, train and/or communicate as required to those accountable for undertaking any aspect of the protocol.

8. **Monitor / audit** the new protocol to ensure it is followed. Use a Gap Analysis technique to compare the expectations as documented in the protocol with the actual documented and observed situation.

9. **Investigate any losses** related to the management activity where a new protocol has been applied. Like monitor / audit, use a Gap Analysis technique in the investigation to compare the expected to the actual situation at the time of the loss.

If this 9 step process is followed the site should have an effective (targeted on highest risk areas), systematic Integrated Risk Management System. The system should be more effective than general OH&S Management Systems for major loss exposures. The successful completion of the 9 steps should also eventually lead to a site where careful, pro-active management is “the way we do business”.

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