DECISION MAKING IN INCIDENT CONTROL TEAMS

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SUMMARY

Often inquiries into mine disasters make mention of the human factors involved in the incident. The purpose of this paper is to explore one such human factor, the decision making process during a mine emergency. Utilising examples from politics, aviation, and mining industries, poor decision making processes will be illustrated. Some of the decision traps discussed include, group think, the Abilene paradox, inappropriately relying on 'rules of thumb', lack of frame control, and confirmation bias. The paper will then describe practical techniques that a mine manager, as incident controller, can apply to improve the group decision making process. Techniques such as devils advocacy, dialectic decision making, scenario development, and decision auditing will be explained. In particular, the use of facilitated risk assessments as a decision making tool during a recent spontaneous combustion incident will be described in detail. Implementation of the decision making principles demonstrated in this paper will provide mine managers with new opportunities for improving the quality of decisions made during mine incidents.

INTRODUCTION

A recent article by Brnich et. al. (1) identified in a major study what subjects members of a mine emergency response team should be trained in. A group of experts with many years of mine disaster response experience was asked what they thought decision makers need to know to effectively manage a mine emergency. They identified five major subject areas: emergency response planning, mine ventilation, mine gas analysis, fire fighting, and mines rescue. Although few people would argue with the technical subjects selected by the experts, it is remarkable that they did not mention the importance of training in the process of decision making. The experts reviewed have assumed that the decision makers will learn by experience through exercising emergency responses. Unfortunately, experience can be a very expensive way to learn proper decision making skills. In fact, few people have ever had any systematic training in how to make decisions.

Initial decisions regarding emergencies are usually not made by a group but are taken by the senior official on site. Historically, many very costly errors have been made during this initial hazard recognition phase of an incident. Recognising this fact safety management plans require triggers to be pre-planned so that as much as possible of the potential for decision making error has been removed from the first level responder. This paper concentrates upon the factors influencing the process of group decision making in incident control teams once the initial incident has occurred.

As in most industries when a major incident develops at a mine external officials become involved in the decision making process. Mine emergency response plans therefore require the formation of an incident control team with membership held by people with the power to implement control procedures. The mine manager is invariably the incident controller as under current legislation he ultimately holds the responsibility for the safety of the people in the mine. He becomes the incident control team leader and therefore most of the responsibility for ensuring a good decision making process falls upon him. The mine manager therefore needs to be aware of the potential problems involved in the group decision making process and the techniques available to enhance the quality of decisions made by an incident control team.

GROUP DECISION MAKING

It is a widely believed myth in management that groups inherently make better decisions than individuals. In his recent book Hilmer et al, (2) states that the preoccupation with teams ignores research findings which have determined that much of a team's effectiveness rests on the expertise of its most skilled member. He quotes from the example given by Yetton et al, (3) in which subjects were told they had crash-landed on the moon with only 15 pieces of equipment available for their trek back to base. They were required to rank the importance of the items and this ranking was compared with the answers of NASA experts. It was found that groups that simply left the task up to the member with the most scientific knowledge of the moon came up with the best solution. Such groups were better at solving the problem than groups that obtained a representative set of views from their members and conducted intense group discussions.

This finding does not mean that teams are useless but it does show that learned expertise is important, and that collective intuition is not necessarily superior to an individual's judgement. In his book on the topic of Managerial Decision Making Huber (4) states, "the actual effectiveness of a decision group is equal to the potential effectiveness that follows from the combined inputs of the members minus the losses in effectiveness that follow from the group processes plus the gains in effectiveness that follow from the group processes." This statement can be more easily followed in the following equation:

Actual Effectiveness = Potential Effectiveness + (Process Gains - Process Losses)

Equation 1: Group Effectiveness Model

The group's potential effectiveness is determined by how well the planning, organising and staffing functions are carried out. In a mine incident control team the staffing function to some extent is outside the control of the incident controller although the planning and organising functions are part of the mine's emergency response plan. Without a high quality rehearsed emergency plan, the potential effectiveness of the incident control team is reduced. The importance of the quality of the mine's emergency plan cannot be understated but it is only one of the factors determining the effectiveness of the incident control team. Even with a high standard emergency plan, poor emergency decisions can be made. This paper will concentrate upon the area of incident management which is often forgotten, the group process gains or losses. Group process gains or losses are largely determined by how well the directing and controlling functions are carried out. These factors are driven by the quality of leadership the incident controller can provide to the group.

GROUP DECISION MAKING - PROCESS LOSSES

Frequently, groups of technically competent, well motivated people have made flawed decisions. Group members sometimes agree to a course of action prematurely and then give each other feedback which makes the group feel certain that it is making the right choice or conversely they may become polarised with members steadfastly taking extreme positions. The following paragraphs detail some of the more common reasons for such behaviour within a decision making group.

Group Think

Two days after his inauguration in January 1961 the President of the United States, John F. Kennedy was briefed upon the CIA plan to over-throw Fidel Castro. The plan involved landing a brigade of 1,400 Cuban exiles onto the beaches of the Bay of Pigs and with the support of guerrillas taking over the country. The assumptions at the foundation of the plan included:

1. No one will know that the United States was responsible for the invasion.
2. The Cuban airforce is so ineffective that it can be knocked out completely before the invasion begins.
3. The fourteen hundred Cuban exiles would have high morale.
4. Castro's army is so weak that the small invasion force will be able to establish a well-protected beachhead.
5. The invasion will touch off a wave of sabotage by the Cuban underground.
6. If the invasion force does not succeed in its primary objective, it will be able to retreat to the safety of the Escambray Mountains.

On April 17, 1961 the invasion began and from the very start things went wrong. The supposedly ineffective Cuban airforce shot down half of the American B-26's attempting to destroy their airfields. A second air strike was called off by the President, as it would have revealed too clearly that the planes belonged to the United States. The Cuban airforce sank two of the four supply ships supporting the invasion force and the other two made a rapid withdrawal. By the second day, the brigade was completely surrounded by twenty thousand troops of Castro's well equipped army. On the third day about twelve hundred members of the invasion force, all of those still alive, were captured and led off to prison camps.

"How could we have been so stupid?" asked President John F. Kennedy. The planning team for this operation included some of the smartest people ever to advise an American President including Robert McNamara, Secretary of Defence who was an ex President of the Ford Motor Company, expert statistician and a member of the faculty of Harvard, and Dean Rusk, Secretary of State, ex head of the Rockefeller Foundation and a very experienced policy maker. A study by psychologist, Irving Janis (5) found that they had allowed the group's internal cohesiveness and loyalty to dominate the decision making process. It was found that Arthur Schlesinger, historian and member of the White House staff had been against the proposal but had not spoken out at meetings for fear of being ridiculed by the majority. Robert Kennedy, Attorney General had in fact taken Schlesinger aside after learning he had opposed the invasion in writing and told him, "You may be right or you may be wrong, but the President has made his mind up. Don't push any further."

Upon analysing numerous such disasters researchers such as Russo et al (6) discovered certain common elements which, although they were apparently innocent, lead the decision making group towards tragedy:

1. **Cohesiveness**. Members know and like each other and want to preserve group harmony. There are perceived to be penalties to members of the group who disagree with the majority position.

2. **High Stress**. The complexity and importance of the decision when combined with a tight deadline put group members under great pressure.

3. **Isolation**. Groups suffering from groupthink were often found to be making decisions in secret limiting the extent to which outsiders can be included into the group decision making process.

4. **Directive Leadership**. The head of the group clearly states up-front the course of action he or she favours.

5. **Illusion of Invulnerability**. Overconfidence often caused from applying the lessons of past successes to new situations in which the underlying assumptions of the past decisions no longer apply.

Group think has been found to be a factor in many historical disasters including Pearl Harbour and the Vietnam War (6). A review of the inquiry into the Box Flat and Kianga disasters reveal that many of the elements of group think were operating in the lead up to the explosions. The Mining Warden heading the inquiry into the Box Flat disaster, Hall (7) submitted that, "though there were experienced men present during and prior to this incident, it seems they did not direct their minds to the potential danger of explosions inherent in the condition that prevailed."

Abilene Paradox

The Abilene Paradox was first described by Harvey (8) and is an extreme form of group think. There are two parts to the Abilene Paradox. The first involves a person's inaccurate assumptions about what others think and believe. This is what social scientists call "pluralistic ignorance" – everybody in a group holds a similar opinion but, ignorant of the opinion of others, believes himself to be the only one feeling that way. The second part of the paradox involves a person's unwillingness to speak up about what they actually believe. It is easier, more comfortable, or less risky to go with what appears to be majority opinion. Part one of the problem is one of information and part two is one of risk.

A tragic example of the potential effect of the Abilene Paradox, as detailed by Job (9), occurred on United Airlines Flight 173 which was the scheduled DC8 flight from New York to Portland on December 28, 1978. A minor undercarriage malfunction occurred on the approach to Portland airport. This did not pose any great crisis as the plane had one hour's fuel in reserve but during the course of the preparations for an emergency landing, the crew totally 'lost the plot'. On final approach the plane ran out of fuel and the four-engined jet crashed six nautical miles short of the runway killing 10 people.

The crew was highly skilled. Captain McBroom aged 52 had been a pilot with United for 27 years with a total of nearly 28,000 flight hours, 5,500 of those as Captain of DC-8s. The first officer, Rodrick Beebe, had 8,000 hours experience whilst the flight engineer, Forrest Mendenhall had in addition to his 3,900 hours as a flight engineer qualified as a commercial multi-engine jet pilot. During the incident, the pilot's attention had been focussed upon the possible failure of the main undercarriage. The co-pilot and flight engineer had followed the directions of their captain, however, they had not kept him fully informed regarding the fuel status assuming that he had fully calculated this into their new flight plan. Under the stress of the situation they had fallen victim to the Abilene Paradox, thinking the person in charge knew what they knew and that stating the obvious would be detrimental to the management of the situation.

The crew became totally preoccupied with the undercarriage problem. It was not until the last engine had flamed out that the co-pilot finally uttered: "Get this .... on the ground!" Investigations after the crash indicated that the undercarriage fault was minor and would not have stopped the aircraft making a normal landing.

This incident exemplified a recurring problem in the airline industry, a breakdown in flightdeck management during a malfunction of aircraft systems in-flight. As a result of this incident the National Transport Safety Board of the United States concluded that assertiveness training, including the need for the expression of concern form part of the standard curricula in the training of all airline flight crew. This practice has since become known throughout the world airline industry as Cockpit Resource Management. Mining incident control teams face a similar possible decision trap without the recognition that such training is necessary.

Inappropriate "Rules of Thumb"

"Rules of Thumb" or more properly heuristics are decision making shortcuts formulated from our learning and experience. They are not necessarily bad, in fact we could not adequately perform our normal daily functions without heuristics. Mistakes occur when we attempt to apply our heuristics to problems outside of our experience. Russo et al (6) details two particularly prevalent heuristics which cause problems with individual and group decision making. Firstly, the tendency to pay too much attention to the most readily available information, availability bias. As detailed in his forthcoming book, Hopkins (10) notes an example of this was the inexplicable failure of management at the Moura No.2 disaster in not utilising the gas chromatograph when other signs of spontaneous combustion became evident. The second is the tendency to excessively anchor opinions in a single statistic or fact which from then on dominates the thinking process. The use of the "rule of thumb" spontaneous combustion incubation period at the Moura No.2 mine of six months was an inappropriate use of such a heuristic.

Lack of Frame Control

Everyone has a set of dominant mental frameworks with which they view problems and attempt to discover solutions. These are called frames (Russo et al 6). Frames are formed from our individual experiences, work history, and education. A knowledge of frames is important for leaders of decision groups especially when structuring the problem, determining when to make decisions, and with what objectives. An incident controller should be able to understand the problem with the frames of the other people in the incident control team. Such an understanding can guide the selection of conflict management methods within the group. One of the key impacts of the frame used by a decision group upon the decision making task is in the area of data gathering. What type, depth and volume of information is required before a decision can be made is driven by the framing of the problem. Usually complex problems should be viewed through several frames concurrently to reach the best solution.

Confirmation Bias

Overconfidence can be expressed in a multitude of ways, one important effect being confirmation bias. People have a tendency to favour data that supports their current beliefs and to dismiss evidence which challenges existing views. Confirmation bias can affect individuals as well as groups. One classic example in which confirmation bias contributed to a poor quality group decision was the Challenger space shuttle disaster.

As detailed in a paper by Hirokawa et al (9) the space shuttle Challenger was destroyed due to a failed set of O-rings within a joint in the solid booster rocket. The cause of the failure of the "O"rings was the low temperature during the period up to and including take-off. Failure by engineers who were against the launch to turn data about low temperature effects upon O-ring performance into information about the risks of a launch made them ineffective in persuading their superiors to support their view not to launch. Technicians had studied the O-rings after each of the thirty earlier space shuttle flights. For seven of those flights, they had discovered serious wear. The positive feedback from twenty-three launches where no wear had occurred had made NASA officials overconfident. The engineers were asked to graph the temperatures at launch for the flights in which problems had occurred. The result appears below as Figure 1.

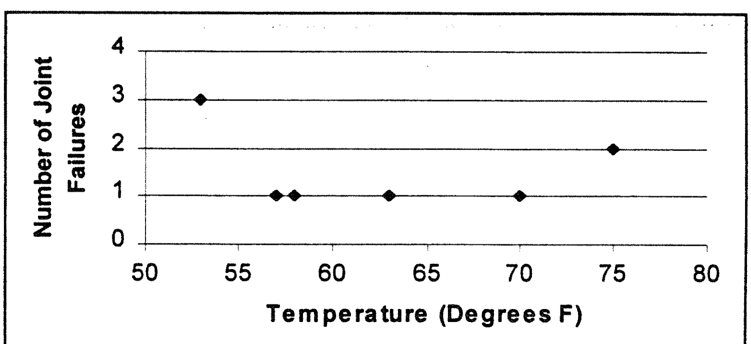

Figure 1 – Information Presented to Decision Team Regarding Joint Failures

The decision making team were not convinced of the engineers concerns. Several problems had occurred in flights at temperatures of 70 degrees or higher. Decision makers at NASA and Morton Thiokol (the rocket booster's builder) agreed that evidence on whether temperatures caused O-ring problems was inconclusive. They gave permission for the launch and the rocket exploded killing seven astronauts. At the inquiry Figure 2 was produced. It is the same as Figure 1 except that it includes data from all flights. As can be seen every flight on which O-rings were not damaged occurred at a temperature above 66 degrees. Temperature in fact did have a dramatic impact upon the incidence of O-ring failure.

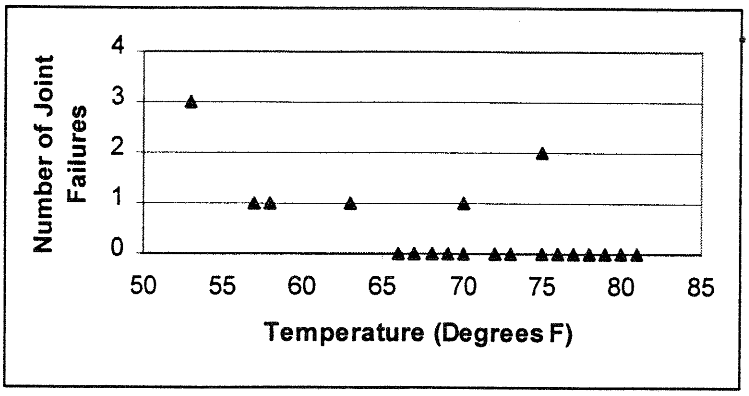

Figure 2 – Full Data From Past Flights Regarding Joint Failures

Proper analysis of data would have provided essential information to the decision makers. The data presented confirmed their existing view that the issue was not critical to the safety of the spacecraft and they did not seek further data which may have refuted their belief.

The inquiry into the Moura No.2 mine disaster uncovered many instances of confirmation bias from the management team at the mine. In particular the warning signs of fire stink and rising carbon monoxide levels indicating spontaneous combustion were ignored or explained away as being unreliable through a process of giving credence to other evidence which confirmed the illusion of normality. Hopkins (10) states that this led to an elaborate culture of denial developing at the mine.

GROUP DECISION MAKING - PROCESS GAINS

The techniques detailed below simultaneously increase the potential for group process gains whilst minimising the impact of group process losses upon the incident control team. Most of the techniques are self evident from an understanding of the potential problems of group decision making. The key for producing process gains from the group decision process is through the sharing of information and experience within the group. To achieve this the incident controller needs to understand and control the factors leading towards group think and the Abilene paradox. In mining incident control teams at least two external people are usually required to form part of the team, the Mines Inspector and the District Check Inspector. This to some extent should assist to decrease the homogeneity of the group and thereby decrease the tendency towards group think. This is critical as studies summarised by Levine et al (11) have shown that groups working in an underground environment typically show that stronger leadership, increased cohesiveness, and greater conformity pressures are all common. Groups that work in such hostile environments apparently try to eliminate or control any internal problems so that their external problems can be dealt with more effectively.

Firstly, it is important to dispel the myth that conflict within groups is bad. The constructive use of managed conflict within decision groups is the primary method of avoiding most group decision traps (Tjosvold, 12). Mr Alfred P. Sloan, the father of General Motors knew this when following a discussion by his key executives about a critical strategic decision he stated the following:

"Gentlemen, I take it we are all in complete agreement on the decision here… Then I propose we postpone further discussion of this matter until our next meeting to give ourselves time to develop disagreement and perhaps gain some understanding of what the decision is all about." (quoted by Russo et al (6))

Devils Advocacy

An individual or group is assigned the role of critic. It needs to be clearly stated by the incident controller that this criticism must not be taken personally, but is part of the decision making process. The person appointed as the devil's advocate should have high status and the position should be formally rotated within the group. Cosier et al (14) have formulated the following model of devil's advocacy:

Steps In A Devils Advocate Decision Program

1. A proposed course of action is generated.
2. A devil's advocate is assigned to criticise the proposal.
3. The critique is presented to key decision-makers.
4. Any additional information relevant to the issues is gathered.
5. The decision to adopt, modify, or discontinue the proposed course of action is taken.
6. The decision is monitored.

Dialectic Decision Making

In this method two groups proposing differing courses of action are set the task of arguing their cases in front of the core members of the decision making team. The benefits of this method are in the presentation and debate of the assumptions underlying proposed courses of action. False or misleading assumptions become apparent and decisions based on these poor assumptions are avoided. There is a danger in using this technique in that it has the potential for it to accentuate who won the debate rather than the best decision. Whilst the devil's advocate technique may focus upon the issues the dialectic method may be best applied where the decision making conditions involve high uncertainty and low information availability. This technique is a good way to define problems and generate needed information for making decisions under uncertainty. When information is available and causal relationships are known the devil's advocate methods are preferred. (Cosier et al (14))

Steps In The Dialectic Decision Method

1. A proposed course of action is generated.
2. Assumptions underlying the proposal are identified.
3. A conflicting counterproposal is generated based on different assumptions.
4. Advocates of each position present and debate the merits of their proposals before key decision makers.
5. The decision to adopt either position, or some other position e.g. a compromise is taken.
6. The decision is monitored.

Scenario Development

The Royal Dutch Shell group is credited with the development of the technique of scenario development for making critical decisions. Russo et al (6) state that Shell usually restricts the number of scenarios to a minimum of two and a maximum of four. Each scenario must have plausible and internally consistent assumptions regarding uncertain future events. Decisions are then based upon the their likely impact under each of the hypothesised scenarios. In effect this technique forces decision makers to utilise different decision frames for the development of the scenarios.

This technique was recently utilised by the author during the early stages of a spontaneous combustion incident to determine the safety of proposed courses of action when a minimal amount of information was available. Scenarios were developed with different assumptions regarding the location and extent of the source of the heating consistent with the known information. Decision trees were then formulated based upon these scenarios. This disciplined decision making technique is useful where there is a limited number of plausible combinations of key assumptions in an environment of high uncertainty.

Structured Risk Assessment

At a recent incident involving spontaneous combustion in an active longwall goaf area, structured risk assessment techniques were effectively utilised as a decision making tool. Concerns were raised by members of the incident control team regarding the potential hazards of two proposed control measures - the drilling of a surface borehole located close to the suspected site of the heating, and the installation of a brattice screen to restrict the intake air to the heating site. At the suggestion of the incident controller two separate risk assessments were initiated to investigate these options. The assessments were facilitated by a member of the mine's management team who had undertaken training in facilitation of risk assessments and the process adopted broadly followed the requirements of the Australian Standard AS4360 on risk assessment. The process involved not just the nucleus of the incident control team but also miner's officers, and other members of the mine management team. Approximately ten people were involved in each risk assessment, both being completed in around four hours. As a result of these assessments new controls were put in place during the drilling of the borehole and the proposal to erect the brattice screen was dropped. A formal review following this incident found that the appropriate course of action had been adopted.

The technique is a form of dialectic decision making in that the people involved in the assessment tended to form two groups which debated the proposals utilising the structured framework of the risk assessment technique. The technique forced people with particular positions to justify those positions through utilising the facts which supported their argument. The assumptions they were making tended to be pointed out by the group opposing the course of action. Critically, due to the high standard of facilitation there were no individuals who could be said to have been winners or losers in the process as people would progressively change their positions as the facts and assumptions not supporting their view became apparent. By the time the risk assessment process had led the group to a closure point, the decision group had reached a consensus upon the appropriate course of action. I strongly recommend the utilisation of the risk assessment technique as a method of facilitating group decision making by the incident control team during a mining incident.

A VIGILANT DECISION MAKING PROCESS

Throughout this paper conceptual tools have been provided which will assist incident control teams to improve the quality of their decisions. A method of implementing these conceptual tools to improve decision making behaviour is to undertake a decision audit. In a decision audit an analysis is undertaken of the decision making process and actions are identified which will improve future decision making.

The first stage in a decision audit is to assess how much time you devote to each of the stages of the decision making process. A suggested format for such an assessment is illustrated below. (Russo et al (6))

	Percentage of Time Spent on Each Phase of the Decision	Percentage of Time Devoted to Each Phase of the Decision in Future
1. Framing the Problem and Process		
2. Information Gathering		
3. Coming to Conclusions		
4. Decision Review		

The second stage in a decision audit is to evaluate at least one decision in which a good result was achieved due to a good decision process and at least one decision where a poor result occurred due to the decision making process. A suggested format for such an evaluation, modified from Russo et al (6), is detailed below.

DECISION EVALUATION FORM	
The decision:	
Decision Traps	**Grade (1 = poor, 10 = excellent)**
1. Plunging In – Beginning to gather information and reach conclusions without first taking a few minutes to think about the problem.	
2. Framing the Decision – Failure to frame the problem in more ways than one.	
3. Inappropriate Use of 'Rules of Thumb' – Implicitly trusting readily available information or anchoring too much on convenient facts.	
4. Overconfidence in Your Judgement – Failure to collect and evaluate information because you were too sure of your assumptions and opinions.	
5. Group Failure – Occurrences of Group think, Abilene paradox or other types of group process problems.	
6. Fooling Yourself About Feedback – Failure to interpret the evidence from past outcomes.	
7. Failure to Review Your Decision Process – Without this step you expose yourself to repeating the mistakes of the past.	
If your decision was a success, what was the key problem you needed to overcome?	
If your decision was a failure, what was the key trap that caused the error?	
Did other problems arise that are not included in the above list of decision traps?	
What is the key thing I have learned from this decision which I will apply in future?	

The final stage in the decision audit process is to make a list of three to seven opportunities for improvement in your own decision making processes utilising the results obtained from the previous two steps. Take action to realise those opportunities and then after a period of time again audit your decision making process and over time you will achieve a superior decision making performance.

CONCLUSION

When reviewing reports of mine disasters observers often ask the question, "How could that group of highly trained people make such a blunder?" As the examples in this paper illustrate it is not just in the mining industry where such questions are asked. The answer can sometimes be found not in a lack of technical knowledge but in failures in the decision making process. Often the incident control team have fallen victim to one or more decision traps which have increased group process losses leading them into making a poor quality decision with tragic consequences.

Mine Managers and other incident control team members need to recognise the importance of not just concentrating on the technical facts they are presented with during a mine incident but also the critical importance of adhering to good decision making processes. It is only through the combination of the skills of a highly technically qualified group of personnel and the application of good group decision making process that high quality decisions will be made.

Of course, the decision making techniques described in this paper are not specific to disaster management, they can be utilised whenever groups of people are required to make important decisions. Training in decision making should therefore form part of the curricula for the education of mine managers and other incident control team members.

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