THE UNIVERSITY OF QUEENSLAND

AUSTRALIA

The impact of non-technical issues on decision-making by coal mining incident management teams.

Ruth Grace Fuller

BEng Hons Civil Engineering

Grad Dip Psychology

BSc Hons Psychology

Grad Dip Secondary Education

A thesis submitted for the degree of Doctor of Philosophy at

The University of Queensland in 2014

Sustainable Minerals Institute

Abstract

A serious incident in an underground coal mine can claim many lives in an instant. The lives of those who survive the initial moments can be dependent on the decisions made by the incident management team (IMT). The IMT is a team of mine employees assembled immediately upon the discovery of an incident to manage the response. Evaluations of annual emergency exercises conducted at underground coal-mines in Queensland have indicated that IMT decision-making is generally sub-optimal. This finding was echoed by the Royal Commission into the New Zealand Pike River Coal Mine Tragedy that occurred in 2010. In many other high-reliability roles technical and non-technical issues have been found to impact decision-making. The goal of this research is to explore the role of non-technical issues in emergency decision-making following an underground coal mining incident. A review of the Queensland emergency exercise reports, direct observation of emergency simulations, and interviews with twenty-five mining personnel with real-life incident management experience at underground coal mine emergencies has led to the development of a non-technical skills taxonomy for decision-making in mining IMTs. The decision-making process in a mining IMT has been shown to be a broad socio-psycho-technical process within which technical and non-technical issues cannot be separated. Technical, social and cognitive skills are imperative to maintain adequate communication, situation awareness and optimal decision-making throughout the emergency management process.

Declaration by author

This thesis is composed of my original work, and contains no material previously published or written by another person except where due reference has been made in the text. I have clearly stated the contribution by others to jointly-authored works that I have included in my thesis.

I have clearly stated the contribution of others to my thesis as a whole, including statistical assistance, survey design, data analysis, significant technical procedures, professional editorial advice, and any other original research work used or reported in my thesis. The content of my thesis is the result of work I have carried out since the commencement of my research higher degree candidature and does not include a substantial part of work that has been submitted to qualify for the award of any other degree or diploma in any university or other tertiary institution. I have clearly stated which parts of my thesis, if any, have been submitted to qualify for another award.

I acknowledge that an electronic copy of my thesis must be lodged with the University Library and, subject to the General Award Rules of The University of Queensland, immediately made available for research and study in accordance with the *Copyright Act 1968*.

I acknowledge that copyright of all material contained in my thesis resides with the copyright holder(s) of that material. Where appropriate I have obtained copyright permission from the copyright holder to reproduce material in this thesis.

Publications during candidature

Fuller, R., Cliff, D. and Horberry, T. (2012). Optimising the Use of an Incident Management System in Coal Mining Emergencies. Australian & New Zealand Disaster and Emergency Management Conference, Brisbane, 16 – 18, April 2012. Available at: http://anzdmc.com.au/proceedings.pdf

Horberry, T., Xiao, T., Fuller, R. and Cliff, D. (2013). The Role of Human Factors and Ergonomics in Mining Emergency Management: Three Case Studies. Int. J. Human Factors and Ergonomics. Vol 2, Nos 2/3, pp116-130

Horberry, T., Burgess-Limerick, R. and Fuller, R. (2013). The Contributions of Human Factors and Ergonomics to a Sustainable Minerals Industry. Ergonomics, 56(3):556-64

Publications included in this thesis

No publications included.

Contributions by others to the thesis

Professor David Cliff suggested researching decision-making in mining IMTs, and introduced the researcher to the mining industry and relevant contacts.

Professor Robin Burgess-Limerick contributed to critically revising the thesis in the last six months of the PhD candidature.

Statement of parts of the thesis submitted to qualify for the award of another degree

None

Acknowledgements

I'd like to acknowledge the support of my supervisors Professor David Cliff and Professor Robin Burgess-Limerick.

I'd like to acknowledge the financial support received from the Minerals Industry Safety and Health Centre in the form of a research scholarship.

I'd further like to acknowledge the significant input from the interviewees. They were extremely generous with their time. Their enthusiasm for my research has motivated me throughout the PhD process and I am extremely grateful that they shared their experiences with me and the industry. I sincerely hope that this thesis meets their expectations.

Thank you to my husband David Fuller for financial support and the final formatting in LaTeX.

Keywords

decision-making, incident control, mining, non-technical skills, situational awareness, communications, stress.

Australian and New Zealand Standard Research Classifications (ANZSRC)

ANZSRC code: 170202, Decision Making, 70%

ANZSRC code: 170107, Industrial and Organisational Psychology, 10%

ANZSRC code: 091405, Mining Engineering, 20%

Fields of Research (FoR) Classification

FoR code: 0914, Resources Engineering and Extractive Metallurgy, 20%

FoR code: 1702, Cognitive Sciences, 80%

Contents

List of Tables

List of Figures

List of Abbreviations

Abbreviation	Definition
AIIMS	Australian Interagency Incident Management System (Australian ICS)
CFMEU	Construction, Forestry, Mining and Energy Union
CIMS	Coordinated Incident Management System (New Zealand ICS)
CRO	Control Room Operator
IC	Incident Controller
ICCS	Incident Command and Control System (NSW mining)
ICS	Incident Control System (used in the US)
IMT	Incident Management Team
MEMS	Mining Emergency Management System (Qld mining)
MRAS	Mining Re-entry Assessment Schedule
NDM	Naturalistic Decision-Making
NZMRS	New Zealand Mines Rescue Service
ppm	parts per million
QMRS	Queensland Mines Rescue Service
RPDM	Recognition Primed Decision-making
SSE	Site Senior Executive
VO	Ventilation Officer

1 Introduction

1.1 Background

At quarter-to-four on the afternoon of the 19th November 2010 at the Pike River Coal mine (NZ) the lights flickered in the statutory mine-manager's office. Alarms sounded in the control room indicating that power, ventilation, pump and gas data were no longer being received. Daniel Duggan, who was operating the control room on the surface of the mine at the time, was cut off whilst speaking to a miner who was working underground. Daniel sought re-connection for four minutes, eventually asking if there was 'anyone underground'. No-one answered.

Daniel had 'a real bad feeling about this'. He told the statutory mine-manager that power and communication in the underground mine had been lost. At 3:52 pm Daniel asked if he should call mines rescue, to which the reply was, 'Oh, we won't go there yet, we'll get someone up there'. Shortly after this, the mine-manager spoke with two other senior personnel in the car-park and they noticed an unusual smell. The mine-manager then returned to his office to work on unrelated emails.

An electrician, Mattheus Strydom, was asked to investigate the outages. Mattheus requested confirmation that both power and communication had both been lost, a significant combination in his experience, as it is typically associated with a major incident destroying the underground infrastructure. Before entering the mine at 4pm, Mattheus commented 'I hope this isn't bad' to a contractor. Upon entering the mine he reported that 'something just didn't feel right' but he continued, easing his concerns by finding rational reasons for the missing reflector sticks, the missing fire hose signs, and the altered position of items on the walls of the mine. He also detected a cordite smell and recognised that his mine vehicle was starting to struggle due to a lack of oxygen. However, it was the sight of a man lying in the roadway, in a position which Mattheus had been taught indicated that he had been killed in the blast of an explosion, that made him rapidly retreat from the mine. During this time senior personnel had met at the mine portal, satisfied themselves that there was a ventilation breeze entering the mine, and had left. At 4:25pm Mattheus called Daniel and said 'You better call the mine rescue, we've had an explosion and I've seen a man lying on his back in the road'.

At 4:26pm, forty-one minutes after the explosion occurred, the statutory mine-manager authorised Daniel to call the mines rescue service and the St John Ambulance. The general manager activated the emergency response management plan at around 4:30pm, 45 minutes after the explosion.

This account of the first 45 minutes following the explosion at the Pike River coal-mine in New Zealand has been constructed from evidence presented at the Royal Commission into this tragedy which killed 29 miners [162]. The Royal Commission found that the simultaneous outages of power and communication systems should have been recognised as indicative of a serious incident, and that the mine's emergency response management plan should have been activated immediately. The emergency management process used throughout the rescue and recovery stage, including the decision-making was found to have 'serious failings'[162, p. 344], 'the emergency response was hampered by a lack of information' [161, p. 26] and the commission recommended that 'Emergency Management in underground coal mines needs urgent attention' [162, p. 354].

However, the problem of poor decision-making is not isolated to the Pike River incident. Similar concerns have been raised by the assessors of 16 annual mine emergency exercises held in Queensland, Australia. This suggests that Incident Management Teams (IMTs) established at underground coal mines generally encounter difficulties making timely and effective decisions. This thesis aims to explore the non-technical issues that may be contributing to these decision-making deficiencies.

Many mines rescue personnel have been killed whilst attempting rescues in underground coal mines. Consequently, decision-making by those managing the emergencies has been scrutinised in formal investigations. At two relatively recent incidents in the U.S.A, both the decision to allow rescuers underground; and the alternate decision to delay sending rescuers underground until the rescuers' safety could be assured, have received criticism, because in both cases the decision resulted in further fatalities. At the Crandall Canyon Mine in Utah (2007), three men attempting to rescue six others who were trapped in the mine following a ground control failure were killed by a subsequent failure [200]. On the other hand, following an explosion at the SAGO mine in West Virginia, the IMT delayed activating rescue crews contributing to the deaths of 11 out of the 12 miners who remained underground to await rescue [130].

These two examples highlight a number of issues. Decision-making following an incident at a coal mine is technically complex because of the inherent instability of a coal mine's structural and atmospheric environment. Decision-makers must deal with competing goals (the safety of the rescuers versus rescuing those underground); extreme time pressure (there may be limited respirable air underground meaning rescuers have a limited time to rescue them); and the fact some decisions can be a matter of life and death.

To appreciate the physical difficulties decision-makers in an IMT must manage following an underground incident at a coal mine, a basic understanding of the working environment is required. The hazards in an underground coal mine include: the threat of water infiltrating the mine (this could result from flooding on the surface, or old adjacent mine workings); the potential for roof collapse (due to the weight of the overlying strata); fire (the whole mine is flammable - the walls, the floors and the roof); pressure outbursts (following strata collapse or a release of pressure build-up in the coal); a build-up of toxic and explosive gasses (these result

naturally in a coal mine due to the reaction between coal and oxygen and can accumulate as a result of poor ventilation or can infiltrate the mine from inadequately sealed off old sections of the mine); and methane or coal dust explosions (due to ignition of the explosive gasses).

Explosions are generally perceived to be the biggest threat to underground coal mine workers because of the potential for multiple fatalities to occur nearly instantly. The atmosphere in an underground coal mine is inherently unstable in that the heat generated from the coal-oxygen chemical reaction can be sufficient on its own to ignite the mine atmosphere if the mine is inadequately ventilated. Consequently the IMT must maintain awareness of the mine ventilation during any incident to prevent a build-up of toxic and flammable gasses that can lead to the incident escalating to an explosion.

Other contextual issues that can influence IMT decision making, some specific to underground coal mines in general and some only specific to Australian mines, include:

- Physical communication with underground personnel is limited to short text messages to key personnel and fixed line telephones installed at various locations in the mine.
- Following an explosion, the physical communication system and gas monitoring systems will most likely be destroyed.
- An explosion can almost instantly kill many people at once, as the force and toxic atmosphere propagates through the mine.
- Miners carry a self-rescuer breathing device that provides them with 40 minutes of respirable air if they are able to put them on before being overcome by the toxic gas. Spare rescuers, and sometimes more robust breathing units, are made available at change-over stations located throughout the mine.
- Workers may be many kilometres from a mine entry/exit making rescue and escape times lengthy.
- The layout of the mine continuously changes because more coal is extracted from new areas of the mine and older areas are sealed off.
- Any item that may spark is prohibited from being taken underground. Only specialised vehicles and equipment can be used underground.
- Daily operations are driven by production. Even short interruptions to production can cost a coal mine millions of dollars.
- A control room officer (CRO) is always on-site to oversee the electronic data monitoring screens that track critical aspects of the mine such as the ventilation.
- Coal mines often operate 24/7 and on back shifts there may only be one or two persons above ground whilst a full crew works underground.

- The Incident Management Team (IMT) managing the emergency remains above ground in mine administration buildings meaning that they are physically isolated from the underground mine and workers during an incident. These buildings also generally house the control room.

These factors impact emergency decision-making in a number of ways. For example, the long distance between the miners and an exit and the limited communication system, means that actioning a decision and getting feedback on its success or otherwise is time consuming. The IMT being located above ground means that they cannot see what has happened and must rely on information from others to determine the situation in the mine. The prohibition of vehicles or equipment that can spark means that the emergency services are unable to use the equipment and transportation they use routinely. The interconnectedness of the mine means that one incident can impact many people in different locations. Further, there may be a shortage of above-ground staff on-shift to take roles in an IMT if an incident occurs on a back-shift.

The last multiple fatality incident at an underground coal-mine in Queensland was an explosion which killed 11 men at Moura No 2 mine in 1994. This was the last in a series of explosions at Moura that claimed a total of 36 lives between 1974 and 1994. The Warden's inquiry into the 1994 incident contributed to the development of new coal mining legislation in Queensland and placed a requirement on Queensland's underground coal mines to test their emergency management procedures annually [144, 222]. As a result, four key strategies have been implemented in Queensland to improve emergency management since this time: Changes to the Coal Mining Safety and Health Act, the implementation of emergency exercises and the development of the Mine Re-entry Assessment System and the Mining Emergency Management System.

1.2 The Coal Mining Safety and Health Act 1999/Coal Mining Safety and Health Regulation 2001

Coal mines in Queensland have a legal responsibility under the Coal Mining Health and Safety Act 1999 [40] to be prepared to respond to emergency situations. The Coal Mining Health and Safety Regulation details procedures that mines must comply with in an effort to prepare them for an emergency [39]. These include the requirements that each mine must develop a safety and health management system and a principal hazard management plan and must carry out risk assessments and work within standard operating procedures.

1.3 Level 1 Exercises

Since 1998, annual full-scale emergency exercises, referred to as Level 1 exercises, have been conducted and assessed in accordance with a recognised standard [81]. The Level 1 exercise is a realistic emergency simulation hosted at a nominated mine anytime within a disclosed two-week timeframe. An independent management committee, generally comprising eight to ten members, confidentially designs and plans the exercise over the course of several months. Professor Cliff, the primary supervisor of this research, has been a member of this committee since 1998, and the researcher was a member for three years from 2011 to 2013.

On the day, the exercise involves the mine (surface and underground), external agencies (e.g. the CFMEU), government agencies (e.g. the Mines Inspectorate), the Queensland Mines Rescue Service (QMRS), the emergency services (e.g. police, ambulance) and often neighbouring coal mines. A team of approximately 25 assessors observe performance in all areas of the mine impacted by the exercise. These include the control room, the room where the IMT meet, the areas where the IMT functional groups work above ground, and the working areas affected underground. The multiple vantage points ensure the complete IMT decision-making process, from gathering the data to actioning the decision, to be captured and evaluated by assessors. Each year a report is published following the exercise [1] using the assessors' comments, observations and recommendations; and each year these reports make recommendations in an effort to improve IMT performance and decision-making.

For example:

> *'A mine must have an established, structured and comprehensive system for managing an emergency with a trained, disciplined response team.'*(2004).

> *'There is a further need to establish a clear organisational structure for the management of an emergency, including information gathering techniques, decision-making processes and communication mechanisms. These are available within professional emergency services organisations and should be reviewed and considered for adaptation to the mining environment.'* (2003)

It is recommendations such as these that prompted the development of the Mines Re-entry Assessment Schedule (MRAS) and the Mining Emergency Management System (MEMS).

1.4 The Mine Re-entry Assessment System (MRAS)

The MRAS is an information management tool. Its purpose is to help IMTs, with the assistance of the QMRS, to decide if they should allow miners to: remain in the mine; to re-enter the mine

[1] The Level 1 emergency exercise reports are available from the Queensland Government website at http://mines.industry.qld.gov.au/safety-and-health/emergency-excercise-reports.htm. References to Level 1 reports in this thesis will simply include the date of the exercise.

following an evacuation; or to send rescue teams into the mine to rescue or recover missing, injured or deceased miners. These decisions are communally termed the 're-entry decision' as they all require the same assurance of safety in the mine. The Moura inquiry specified that 'Before re-entry is decided, the risks and benefits must be fully analysed.' [222, p. 67] and also that re-entry to recover bodies should not be considered an emergency. The re-entry decision is conventionally a core mines rescue activity [144] because of the potential for would-be rescuers to become victims. The QMRS' philosophy is that the re-entry decision must be made analytically using complete and accurate data to show, without a doubt, that the mine environment is safe. 'The decision makers' authorisation to re-enter the mine must be unmistakable, deliberate and well informed.' [145].

The MRAS facilitates the digital collection and collation of technical mine data, such as historical gas readings, prior to an incident occurring. It has been identified that approximately 70% of the technical data required in an emergency exists before it occurs [143]. Therefore, having this data readily accessible when an incident occurs should, in theory, enable decision-makers to make a more rapid and informed re-entry decision. The MRAS was deliberately designed to direct the decision-makers towards the relevant data but not to make the decision for them, thus differentiating between data gathering and decision-making [28]. The MRAS was first used in a real situation at the Pike River Coal Mine in 2010 and supported the decision not to deploy mines rescue [145]. This decision came only minutes before the mine exploded for the second time and prevented the deaths of rescue workers who were keen to enter the mine [161].

1.5 The Mining Emergency Management System (MEMS)

The MEMS is a management structure developed specifically for the management of a mining incident. It is a command and control model that outlines the roles and responsibilities of the people working within it. It is an adaptation of the Incident Control System (ICS) used by the emergency services and government agencies during civil disasters in the U.S.A. The ICS also forms the basis of the Australian Inter-service Incident Management System (AIIMS) and the New Zealand Coordinated Incident Management System (CIMS), used by the emergency services of the respective countries. The purpose of these systems is to maintain control and coordination of an emergency response when multiple agencies are required to work together, such as the police, fire and ambulance services [65, 21]. However, during the rescue and recovery stages at the Pike River Mine a mixture of ICS from the UK and NZ were applied by the Police and this affected the efficiency of the decision-making [161]. The Royal Commission recommended that 'The implementation of the co-ordinated incident management system (CIMS) in underground coal mine emergencies should be reviewed urgently' [162, p. 355].

The MEMS training manual defines an incident as 'an unplanned event that impacts upon the safety and welfare of personnel, or the continuity of viable mining operations, which requires

an effective and timely response in order to contain or mitigate the situation' [178, p. 6]. MEMS prescribes establishing an Incident Management Team (IMT) immediately following the discovery of an incident. Mine employees on-site at the time are recruited to fill critical roles in the IMT until they can be relieved by more suitable personnel. This includes the role of Incident Controller (IC). This initial stage of an incident response is generally characterised by a lack of information and 'confusion and disorder' [68, p. 106], especially when people are unaccounted for.

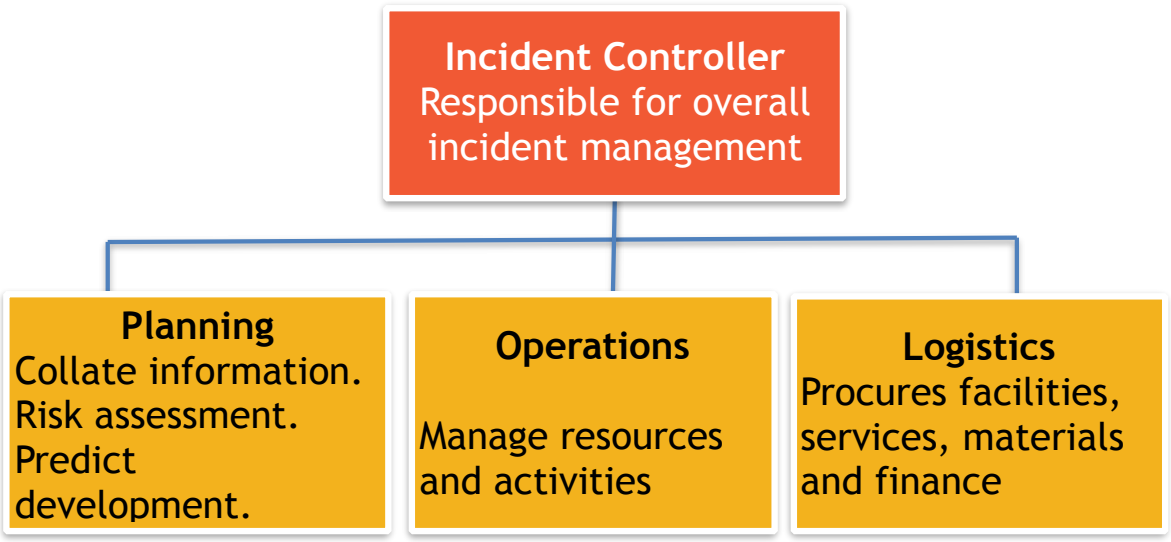

Figure 1.1: Mining Emergency Management System

The MEMS structure is shown in Figure 1.1. It includes three functional groups; operations, planning and logistics. The leaders of these functional groups form the IMT, alongside the IC and any other roles identified as necessary at the time, for example a mines rescue representative. A key principle of MEMS is that the IC is 'responsible for managing the entire response to the incident' [178, p. 7]. MEMS states that at a mine, the IC is either the mine-manager, the site safety executive or the senior mine official. However, in Queensland the IC role has generally been held by the mine-manager, due to his/her statutory responsibility for the mine and all who enter it under the Coal Mining Safety and Health Act [40, 39]. The NSW mining industry have recently adopted a command and control structure similar to MEMS providing some consistency in coal-mining emergency management in Australia [169]. However, the NSW Mines Rescue Incident Command and Control System (ICCS), acknowledges that the severity of an incident may mean that the police will take control of the incident, a consideration not made within MEMS.

IMT meetings are critical to the MEMS process because they are the primary source of information for the IC and are where decisions are made. The functional group leaders share information with each other and inform the IC of information and action status at these meetings. The IC makes decisions by creating and approving action plans. Interestingly, the MEMS

training guide does not specifically list decision-making as a role of the IC. During a coal mining emergency in Queensland, mine workers from other mines, the emergency services (usually police and ambulance), the mines inspectorate, other Government agencies and the QMRS will attend the mine. Implementation of the MEMS should mean that in the event of an emergency, all attending agencies will operate within a similar command structure, theoretically facilitating effective performance.

The Australian mining industry's expectation that adhering to an incident control system and its associated pre-prepared procedures and checklists, such as duty-cards and trigger action response plans, will improve decision-making is based on the assumption that optimal decision-making is solely reliant on complete technical data and adherence to a process. It assumes that optimal decision-making is methodical and analytical and consequently that the implementation of a logical and methodical decision-making processes will ensure an optimal outcome. This is a reasonable assumption given that setting standards, defining objectives, achieving goals and following standard operating procedures are the norm in the industry and have been effective in many cases, but the evidence from Level 1 exercises and Pike River suggests that the existence of these predefined systems may be insufficient, on their own, to improve performance in the emergency environment.

The application of work processes that are suited to daily operations, and embedding these into a command and control structure that was developed for experienced emergency-services response teams,who are familiar with the emergency environment and the command and control structure, may not be ideal for mining IMTs who are novices in the emergency environment and are unfamiliar with the ICS structure. The superimposition of such systems and processes on a mining IMT overlooks the skills and abilities that the people implementing the systems may need. People are expected to simply slot into the roles and complete the prescribed tasks without consideration of their emergency decision-making experience or the level of training they have received. Mining IMTs are expected to make decisions in a very different environment to that of their daily production-oriented roles. The impact of people's physiological, psychological or social reactions to the incident itself has generally been ignored except perhaps for the proviso in MEMS that the IMT should isolate itself to minimise disturbances.

It is difficult to believe that people involved in a mining IMT would remain psychologically and physiologically unaffected at a time when colleagues, including best mates and potentially close family members cannot be contacted in a mine that has just exploded and is potentially on fire. This was exactly the scenario at Pike River. In the first hour alone it was evident that behaviours were being influenced by individuals' psychological response to the situation. The summary at the beginning of this thesis shows the unwillingness of those on the surface to interpret the available information as evidence of a serious incident.

The implementation of systems to control data (such as the MRAS), to structure team interaction (MEMS) and to distribute roles and responsibilities (the duty card system) are an attempt by the industry to mitigate the impact of stress and emotion on IMT performance

and improve decision-making. However, there is no evidence that such systems can do this in a mining emergency environment and only evidence to the contrary from mining emergency exercises: Despite implementation of these processes assessors still believe decision-making needs improvement. This indicates that the implementation of such systems alone are insufficient to noticeably improve decision-making, and suggests that other factors, which cannot be controlled by these systems may be influencing IMT decision-making. Therefore, exploration of the issues that mining IMT members encounter, with a view to determining if and how they interact with decision-making, is worthwhile.

Issues relating to the unfamiliar emergency environment and IMT members' reactions to this are likely to be influencing decision-making. A critical difference between the mining IMT and IMTs in other industries is that the mining IC is a novice in emergency situations, whereas other ICs are generally extensively trained or frequently make decisions in emergency situations, such as fire commanders and other emergency services personnel. To these personnel the emergency environment, and their reactions to it, are familiar.

Research conducted in other high reliability industries, defined as those that have a good safety record but that are hazardous [59], such as nuclear control plants, the military, aviation and surgery, has identified seven key social and cognitive skills that can improve performance in daily operations and in emergencies [73]. These are decision-making, situation-awareness, communication, leadership, teamwork, stress management and fatigue management. These are called 'non-technical skills' to differentiate them from the 'technical-skills' that these professionals need to perform their roles. At a superficial level these skills appear equally relevant to the mining IMT, but they cannot be generalised across industries. Therefore, before identifying potentially beneficial skills, the non-technical issues that impact mining IMT decision-making must be identified [73]. Thus, this thesis aims to identify and describe the issues that impact IMT decision-making at underground coal mines.

1.6 Research Question

What roles do non-technical issues play in incident management team decision-making during emergencies at underground coal mines?

1.7 Aims and Objectives

The aim of this research is to explore and describe the non-technical issues that may impact decision-making in a mining IMT. The objective is to develop a taxonomy that describes the key non-technical issues that impact on decision-making in mining IMTs.

1.8 Thesis Outline

In Chapter 2 a description of the emergency environment at an underground coal mine is provided to familiarise the reader with the unique context for this IMT research. This is followed by a review of the decision-making literature, incident command system literature, non-technical skills literature and literature pertaining to each of the non-technical issues that affect performance in other high-reliability industries. This chapter forms the basis for the next three chapters that examine emergency exercise reports, direct observations of IMTs during emergency exercises and interviews with experienced miners to understand the non-technical issues that impact decision-making in the mining IMT.

In Chapter 3, Level 1 emergency exercise reports are examined for evidence that non-technical issues may have contributed to the decision-making flaws noted in the reports. These reports are written by experienced coal mining personnel and although an important source of information, they do not provide a comprehensive evaluation of the non-technical issues. The omission of details regarding non-technical issues cannot be considered a representation of their unimportance; rather it reveals an opportunity for improvement as their omission is likely to be because they are difficult to observe and articulate and potentially because of their perceived lowly status in an otherwise tangible and technical working environment.

Chapter 4 outlines observations of IMTs conducted during mine emergency simulations and reveals that non-technical issues can influence decision-making in emergency exercises. The mechanisms by which they appear to have impacted decision-making are discussed. However, several non-technical issues that would be expected in a multiple-fatality incident were not observed highlighting potential differences between the emergency environment created in an exercise versus real-life.

Chapter 5 describes conversational interviews undertaken with 25 miners who have real-life experience in emergency management. The non-technical issues that they believe have impacted decision-making in previous real-life IMTs are identified and explored. The narratives provide a rich understanding of the emergency environment of an underground coal-mine and the resulting physiological, psychological and social issues that impact the decision-making process. The findings of this research are summarised by the development of a decision-making non-technical issues taxonomy.

Chapter 6 outlines the broad definition of decision-making as it applies to mining IMTs. The major findings discussed include the importance of maintaining effective communication to obtain and maintain situation-awareness of the incident and the emergency management effort as a whole; the causes and debilitating effects that interpersonal conflict can have on critical interpersonal communication; the impact of one's own and others emotion and stress reactions; the role trust plays in data validation and the need to care and empathise with fellow workers to maximise the performance of the IMT.

2 Literature Review

2.1 Decision-Making

This thesis is concerned with understanding emergency decision-making in mining IMTs. Efficient and effective decision-making following a serious incident at an underground coal mine is critical to sustain lives and prevent further injuries or fatalities. Emergency management and emergency decision-making are synonymous because decision-making is the critical performance measure of emergency management [36]. However, several contextual issues mean that a mining IMT is not a typical emergency management team such as those comprised of emergency services personnel. In particular, the mining IC and IMT are inexperienced in managing emergencies and are not rigorously trained or selected for their emergency management skills.

Each one of us makes many decisions every day. 'Decision-making' is a familiar task and is common terminology. Yet, understanding how the contextual issues surrounding the mining IMT may impact IMT decision-making, what constitutes IMT decision-making, and where its boundaries lie, is difficult to define due to the cognitive nature of decision-making.

Exploring decision-making as a research topic requires more than assessing the outcome of a decision because the outcome does not necessarily reflect the quality of the decision-making process [67], and hindsight bias can easily distort a post-hoc evaluation of it [51]. A positive emergency management outcome could be the result of good fortune, rather than a good decision-making process; just as a negative outcome may be the result of something unforeseeable rather than a flawed decision-making process [148]. This distinction is often obscured. Further, evaluating a decision outcome in terms of being good or bad is based on the evaluators perspective [184]. For example, the police at Pike River deemed the decision-making process to have went well because no further deaths occurred during the rescue and recovery stage [203]. This is a common evaluation criteria in the emergency services [183] but is unlikely to represent a good outcome from the viewpoint of the families whose loved ones remain in the Pike River mine.

The multitude of issues that must be addressed to understand IMT decision-making mean that several bodies of literature have guided this research. These include the mining literature, psychological decision-making literature, naturalistic decision-making literature, incident command literature including the design and development of ICS systems, the non-technical skills literature and situation awareness literature.

The majority of the mining literature examining human behaviour in emergencies has been produced by scientists at NIOSH in the U.S.A. However, only in the last 25 years have behavioural aspects been considered [20]. There have been calls made for further behavioural and psycho-social research on decision-making during emergency management [112, 111, 20]. Decision-making and leadership issues encountered by miners who are underground in the

'first-moments' following the discovery of an incident, such as an underground fire have been examined [113, 30, 205, 202, 212]. Decisions in this case are about reacting to physical danger, such as escaping [205, 20] and are therefore contextually different to IMT decision-making which is isolated from the scene and personal safety is rarely an issue. Communication issues between miners who are underground and those in decision-making roles has also been investigated due to the criticality of making sure the messages received are appropriate, accurate and complete [126, 127, 128].

One NIOSH narrative study captured the real-life experiences of mine veterans who had experience in emergency response. These mine veterans observed that some leaders had expert technical knowledge, but were poor decision-makers, and that the opposite was true of others [211]. The mine veterans interviewed placed importance on factors such as teamwork, trust and practice [211]. Other mining research has raised questions regarding the efficiency of collaborative decision-making during an emergency [198] and several decision-making techniques have been highlighted to assist mining IMTs avoid common psychological biases [111, 198]. However, decision-making in the mining IMT remains relatively unexplored.

Much of the psychological decision-making literature is framed around a cognitive information-processing model where information is sought, options are methodically analysed and a deliberative comparison of alternatives results in an optimal choice [90]. Expected utility and rational choice decision-making methods are examples of such methods [179]. Figure 2.1 outlines the key steps captured by these decision-making processes.

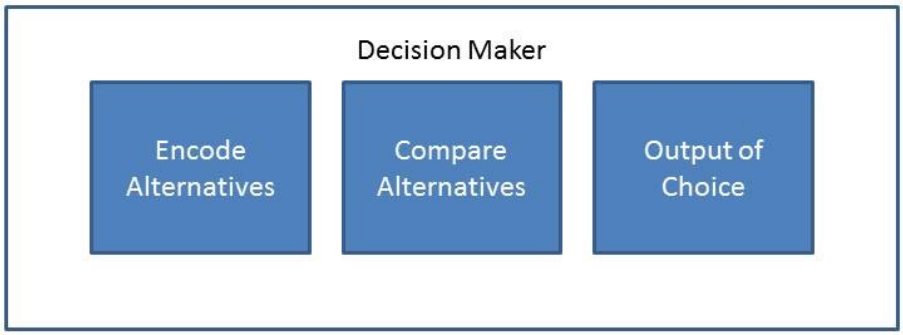

Figure 2.1: Information Processing Model of Decision-Making

This understanding of the decision-making process aligns with the rational and analytical decision-making processes promoted by the Queensland mining industry's Level 1 reports:

> *'each decision needs to be driven to completion. Techniques to capture ideas, generate alternatives and evaluate different options to allow for systematic comparison'* (2002).

However, many factors have been shown experimentally to impair this analytical type of decision-making. In particular, there are robust findings that conditions of extreme stress and

emotion impair decision-making because it reduces cognitive functioning [55, 70, 90]. Given that stress and emotion are expected in a mining IMT, the literature as a whole suggests that this analytical and process driven decision-making process, assumed by the industry to be appropriate, is particularly vulnerable to non-technical issues [155, 117, 158, 67].

Furthermore, the psychological research these conclusions are based on are generally context free, laboratory based and single-variable experiments, a condition unlike the real world [67]. The benign and short-lived stressors that can be induced ethically in a laboratory are unlikely to replicate the intensity of those potentially experienced in a real mining emergency thus reducing its applicability to extreme situations such as military decision-making [55] and potentially the mining IMT. Therefore, despite the perceived advantages of adopting an analytical, comparison based, decision-making process it seems this may do little to counteract the impact of some non-technical issues.

It is idealistic to expect that the rational-choice process would be employed in the real world [207]. The manipulation employed in many of the psychological experiments, where the analytical models of decision-making have been used, may have actually influenced the type of decision-making process used by the participants. The way participants made decisions in these experiments may not have been the way they would normally have made them meaning that it may be more realistic to study decision-makers in their natural decision-making environment [122, 106, 2, 228, 142, 206].

The concept of naturalistic decision-making developed from a realisation that in some high-risk industries, such as fire-fighting and the military, people make quick, almost instantaneous decisions [102, 106]. The complexity of the situations and the speed of their decision-making made researchers doubt that decision-makers were working through an analysis, weighing up alternatives and making an optimal choice, as previous research had assumed. Further, the decision-makers stated that they only considered one option and flatly refuted suggestions that they were considering several alternatives and making a choice [106]. This initiated a research program into naturalistic decision-making (NDM) processes [102, 104, 132, 183, 228].

Naturalistic decision-making researchers focussed on understanding how people make decisions in environments categorised by time-pressure, high-stakes, ill-defined goals, dynamism, ambiguous information, high-risks, multiple-players and organisational constraints [67, 1, 150]. Many models have been developed [121]. One of these is the Recognition Primed Decision-Making Model (RPDM) , which is said to be representative of the decision-making processes used by pilots, intensive care nurses, firefighters, offshore installation managers, naval officers and soldiers [91, 73, 67, 29, 30, 102].

RPDM is sometimes described as intuitive decision-making because people may not realise that they have made a decision as no conscious cognitive analysis is conducted [14]. RPDM describes a process by which experts use available environmental cues to recognise a situation using their previous experience, and once the situation is recognised, a course of action is chosen. If there is time available, the decision-maker may mentally simulate the outcome of this action,

and if it is not suitable, a more appropriate action may be sought and simulated [106]. A critical pre-requisite for RPDM is relevant technical experience to enable recognition of the situation and mental simulation of the proposed solution. Feature matching and story building are the two key diagnostic strategies used to recognise the problem [228] and experts normally develop a suitable solution on their first attempt [107]. Studies have revealed that experts rarely improve upon their initial intuitive solution if they undertake a subsequent analytical decision-making process [14].

Researchers have suggested that apparently very complex analysis can be conducted by experts without great cognitive effort because experts can access an abundance of salient information gathered from previous experience and the environment [14]. This is in contrast to employing analytical processes which require a large amount of cognitive effort and working memory capacity. These capacities are especially vulnerable to impact by non-technical issues such as stress [14]. Naturalistic decision-making highlight that 'Intuition is not a shortcut to deliberation, but something different' [14, p. 286].

Both analytical and intuitive methods of decision-making are equally valid methods of decision-making depending on the circumstances and the decisions that need to be made and However, taken to extremes, both are impractical for the real-world. A fire-commander spending time undertaking an analytical decision-making process may lose control of the fire, and from a pragmatic perspective, the mining industry would not be supportive of IMTs basing the re-entry decision on intuition alone. What the NDM literature suggests is that senior mining personnel may have a natural tendency towards using intuition because of the implicit knowledge that they have. The fact that many experienced miners at Pike River concluded, much earlier than the official IMT driven by the police, that the missing miners had not survived (rightly or wrongly) is an example of this [161].

Over the course of an incident decision-makers have been shown to use both analytical and intuitive strategies [42], with experts potentially using analytical and intuitive strategies simultaneously [14, 52, 70]. Indeed, neurological and psychological research indicates that emotion is an inherent part of the decision-making process [13, 179, 166] indicating that considering intuitive and analytical decision-making as distinct and opposing decision-making processes is potentially flawed. Essentially it has been agreed, that experienced decision-makers use a two stage model. They recognise a situation and they take action. For experts, recognising the situation means knowing what to do [101, 228, 106, 149].

Given the large number of decisions that must be made in a mining IMT, including the re-entry decision amongst many others, it seems likely a number of decision-making processes may be used at different times and for different purposes throughout the emergency management operation. Effective crews modify their decision-making process to the situation [68]. This means that prescribing or legitimising the use of only one decision-making method is potentially detrimental to an IMT's performance. Factors that can determine which decision-making process is optimum include who is making the decision, their expertise, how familiar the situ-

ation is, the time available, the risk involved, the resources available and the rules that must be applied [73]. Flin et al (2008), has outlined four types of decision-making processes used in industry when an unexpected incident happens: recognition-primed, rule-based, choice and creative decisions. These processes range from being intuitive to analytical and require varying levels of cognitive effort. Faster decisions result from intuition or rules (recognition-primed and rule based methods) and analytical processes (choice and creative methods) are time intensive because various options are evaluated. At a coal mine, as in many industrial settings, there are operational guidelines and procedures that dictate some decisions, for example, the methane level in the mine that triggers an evacuation. Analytical methods are generally used when the problem is more complex, there is more time, or if the person making the decision is a novice and the problem needs to be worked through from first principles [68, 78]. In some instances doing nothing is a decision.

The decision-making literature discussed so far only addresses the cognitive component of decision-making. It seems that this is where many researchers see the decision-making process begin and end [67]. Further, in the emergency management literature, most research is conducted on people who are experienced emergency decision-makers. Neither literature fully captures the difficulties that the mining IC and IMT may encounter when making emergency decisions.

However, managers of off-shore oil and gas rigs, often located many hundreds of miles from civilisation, are in a similar position to a mine-manager when disaster strikes. They are not trained incident controllers, they are isolated from conventional emergency services, they work within a highly structured and risk averse industry that is inherently hazardous, and they become the incident controller in the event of an emergency [118]. Research with offshore installation managers revealed that most decisions made during emergency simulations resulted from the evaluation of one option or used standard operating procedures; decisions were not made by comparing alternatives [186]. It was however observed that they had to address sub-goals as part of the process towards reaching the main goal [186]. The researchers explained that decision-making 'refers to the complete set of activities required to select and execute actions, from information gathering and interpretation, via goal specification, to selection and execution of courses of actions' [186, p. 134]. This highlights that decision-making process in such an environment may be broader than what is conventionally covered by decision-making literature.

Another consideration for the mining IMT is that the decision-making is not necessarily an individual process. The IC is responsible for the decisions but the incident management team's role is to help him/her make decisions by gathering and processing information for him/her [68]. Effective decision-making relies on the teams' collective understanding of the situation and is highly reliant on communication to integrate information and team members' interpretation of the situation [73]. Group decision-making brings with it additional social issues that are not present with individual decision-making such as communication, pressure to

conform, individual motives, opinions, attitudes, agendas, and differing perceptions that must be addressed to reach a team decision [73]. An understanding of decision-making in a mining IMT must include these social issues.

A critical component of decision-making, is situation-awareness. This is often described as knowing what is going on around you and is required before any decisions can be made relating to the situation. Situation-awareness has received a significant amount of attention in high-reliability roles such fire-fighters, nuclear power-plant operators, pilots and surgeons [73]. Researchers have analysed how such people scan data monitoring screens or use their senses to 'size-up' what has happened [60], However, unlike these industries, MEMS deliberately distances the IMT from the response itself meaning that the IC has no direct access to the situation or raw data that could help form situation-awareness such as a fire-commander observing a fire or a pilot monitoring cockpit displays. This means that although the IC is a technical person, and the IMT is physically located at the mine-site, the processes used are more akin to that of a remote command centre with senior officials managing a large-scale crisis. The IC cannot sense the situation or take action directly. The IC is dependent on the IMT and others for information and to action his/her decisions. The IC's situation-awareness is wholly dependent on communication and others interpretations of the data. However, those that supply the IC with information are just as unfamiliar with the emergency environment and may also be psychologically and physiologically affected by the incident. This has the potential to influence their interpretation of the data and their communication skills.

The decision-making process in a mining IMT is much broader than previous decision-making processes documented and is heavily dependent on the context [11]. The decision-making process is more than the cognitive process alone. It is heavily reliant on communication and consequently the decision-making process must include the social issues that are inherent in the process of communicating, establishing collective situation-awareness and making team decisions. This research considers the decision-making process to span from the time data is initially gathered and communicated, through to the actioning of decisions, which incorporates the demands and constraints placed on individuals from the emergency environment and the inherent mining culture. The organisational, social and personal pressures [11] compound the pressures of making a technical decision in an often technically ambiguous situation. Therefore, the decision-making process in a mining IMT is a complex and highly coupled psycho-socio-technical system.

The following sections discuss the issues believed to be critical within this process. This includes a discussion of incident control systems and the relevant aspects of non-technical issues that have been highlighted in previous non-technical skills research, namely: leadership, teamwork, situation-awareness and communication. Given the focus on trust within previous mining industry literature this is also included, as is emotion, following the police response-coordinator's assertion during the Pike River Royal Commission that 'fatigue and emotion are very difficult to manage' [204, p. 1744].

2.2 Using an incident control system in the mining IMT

Some researchers have suggested that a command and control structure is ineffective in emergencies and that decision-making would be improved by implementing a flatter and more co-operative structure [6, 210]. However, employing an incident control system to manage an emergency is common amongst the emergency services and within Government agencies when a complex or large incident needs to be managed. The incident control system (ICS) is essentially 'a bureaucratic system that requires *certain conditions* for it to work well" (emphasis added) [21, p. 15]. The first incident control system was developed in the USA for use by wildfire fighters. These teams consisted of members who had worked up through the ranks together, learnt from their superiors and formed strong interpersonal relationships by working together in many emergency situations [103]. Therefore, the social and emotional skills developed through this experience may be the *certain conditions* that are required for an ICS to work well.

It has been suggested that the ICS may not to generalise well to industries outside of that for which it was designed [125] indicating that an ICS may not be particularly effective for mining incidents due to the vast difference in emergency management experience between the experienced emergency response teams the ICS was designed for and a mining IMT which has little or no emergency response experience. For example the fire commander, for whom the system was designed, has the following advantages over a mining IC: the fire-commander is an expert in making decisions in emergency situations; he and his team are trained to deal with emergency situations; he and his team have experience working together and making decisions together in emergency environments; the emergency environment is familiar to him and his team; the team know how they and their team-mates react in the emergency environment and the ICS/AIIMS structure is used routinely. Aspects of these differences may need to be addressed before a mining IMT can benefit from the implementation of an ICS.

Interpersonal relationships between individuals and agencies involved in the response are required for the successful implementation of an ICS [21, 184, 12]. In the emergency services problems have been noted with collaboration and communication and with scaling the system up to incorporate different agencies in large scale incidents when interpersonal knowledge or training is absent [174, 21, 66, 154]. The incident control system was heavily criticised following 9/11 [48] , Hurricane Katrina and Hurricane Rita [32, 125] where centralised decision-making caused communication difficulties and resulted in delays in providing assistance. This was attributed to the command centre's lack of situation awareness [215]. Indeed, if the system can become ineffective within agencies where it is used frequently or practiced often it seems inappropriate to believe the system alone, without the pre-requisite social skills and extensive training, can solve the decision-making issues in mining IMTs.

The Pike River Royal Commission highlighted a number of issues that arose from the implementation of ICS methods. The report claims the problems started when the police took charge of the incident and filled all the IMT roles, including the IC, with police personnel [161].

This led to critical decisions being made without the input of mining personnel. Sticking to the hierarchy took precedence over effective decision-making resulting in significant delays because the approval of risk assessments was delegated to senior police personnel located off-site where technical knowledge was generally unavailable until the police formed an independent technical panel five days after the first explosion. A significant side-effect of this process was the divide it created between agencies which negatively impacted communication, trust, inter-agency and interpersonal relationships.

In summary, the literature suggests that successful decision-making in a critical incident is 'dependent not only on endogenous, situation-specific training of individuals, but also on the interconnected exogenous factors associated with inter-team coordination and strategic response' [1, p. 261] and that incident command systems are simply 'an effective set of principles for coordinating the activities of well-trained and integrated communities' [21, p. 14]. This means that the implementing an ICS in a mining IMT, on its own, does not automatically generate better performance. The incident control system is a structure alone, it does not decrease role conflict, work overload, role clarity, team task orientation, team coordination, team cohesion, team pride or job satisfaction [125] and in some cases is believed to be detrimental to collaboration [6], communication [215] and trust [82, 132] and lead to teams working towards their own goals rather than the overall goal [132]. The incident management literature highlights skills such as teamwork and communication as being critical for effective emergency response within the aviation, military, nuclear control, maritime, rail, health, fire services, and offshore oil and gas industries [73]. Increasingly it is these social and cognitive skills, termed 'non-technical skills', that are the focus of incident control training [45]. Given that critical decisions in a mining IMT are made by people who are inexperienced at making decisions in an emergency environment, and thus may be unfamiliar with how non-technical issues can impact their decision-making, improving the industry's understanding of non-technical issues may be the key to enhancing the effectiveness of MEMS and improving emergency management decision-making in the mining industry.

2.3 Non-technical issues

In response to a number of aviation tragedies that were attributed to human error researchers began exploring the non-technical issues that may be critical in a cockpit [220, 84]. The philosophy was to make sure that the technical skills of the pilot and co-pilot were supported, or even enhanced, by their psychological and social skills. A number of non-technical skills were identified, and in the 1980s, cockpit resource management training was developed. Today, this is called crew resource management and it is considered best practice for all pilots to receive such training [8]. Following the success of crew resource management training in aviation, researchers began identifying the non-technical skills considered important to improve work performance in a number of other occupations with a low tolerance for error such as surgeons, anaesthetists,

nuclear plant operators, and offshore installation managers responding to emergencies [46, 44, 71, 77, 147, 168, 180, 226].

From this body of research some key categories of non-technical skills have been found to be relatively generic across these roles. These include decision-making, situation-awareness, communications, teamwork, leadership and stress and fatigue management [73]. Other categories of non-technical skills have been identified for other industries. For example assertiveness for co-pilots in aviation, and understanding one's own personal limitations in the case of offshore installation managers [68]. Generalising across industries is inappropriate because of these differences and because the categories are domain specific [186]. Consequently, the non-technical issues specific to each workplace being must be identified and examined [45].

It has been recognised that, 'The non-technical skills of an organisation's emergency response personnel are as important as their technical expertise and knowledge and application of emergency operating procedures.' [43, p. 255], and at a high level it can be appreciated that similar skills may improve the performance of mining IMT. However, the categories outlined above are broad and mean little without understanding what lies within them in the context of a mining IMT. Given the assertion of the author that decision-making is highly dependent on issues that arise in the psycho-socio-technical process of a mining IMT[1], primarily situation-awareness, which in turn relies on issues such as communication, teamwork, leadership and stress and fatigue management, it is important to understand the details of each of these non-technical issues.

In 2014 the NSW mine safety advisory board acknowledged the significance of non-technical skills and rolled out an Action Learning Program addressing Associated Non-Technical Skills (ANTS) [38] The program has adopted five of the generic non-technical skills identified by Flin et al 2008: situation-awareness, decision-making, leadership, teamwork and communication, with little tailoring to the mining context. The learning program is directed at normal operations but within the NSW mines rescue ICCS Guide it is acknowledged that non-technical skills are required, in addition to technical skills, for the system to function [169]. Further, the QLD mines rescue service have expressed an interest in adding non-technical skills training to their existing MEMS programs. The current research, by identifying the details of the non-technical issues relevant to IMT decision-making, will contribute to the development of such training.

2.3.1 Situation Awareness

Endsley defines situation-awareness as 'the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future' [59, p. 792]. This definition incorporates three levels of situation-awareness: Level 1 - perception, Level 2 - understanding and Level 3 - projection.

[1]The relationship between decision-making and the other psycho-social issues can be two-way, but when decision-making is the outcome it is always dependent on having situational-awareness.

Level 1 is essentially receipt of the data and is where most deficits are said to occur because data were not available, data were difficult to detect/perceive, there was a failure to scan or observe data or there was a misperception of data [60, 73]. Level 2 is where the observer makes sense of the data using the interaction of existing schemata with knowledge and data [195, 194]. Level 3 is about predicting how the situation is likely to develop and requires higher levels of cognitive processing than the preceding levels. It is also essential to stay ahead of the situation, especially in environments such as coal mines, where implementing decisions can take a long time [201].

Situation awareness is said to be the 'cornerstone' of decision-making [185, p. 3]. Essentially there are two stages to making a decision: recognising the problem, and identifying a course of action [152]. This implies that there are essentially two ways a decision can go wrong. The interpretation of the situation can be inaccurate or the situation is understood correctly but the wrong course of action is chosen [153]. However, in most cases a poor decision is the result of inaccurate or incomplete situation awareness [152]. Optimal situation-awareness does not guarantee good decisions or performance [6], but without situation-awareness the chances of optimal decisions and performance are slim [61].

The ability to achieve and maintain accurate situation-awareness has been identified as a critical non-technical skill in healthcare, aviation, the military, nuclear control plants, offshore oil and gas [73], but the literature is divided regarding whether situation-awareness is a process of becoming aware, or the end result i.e. the state of awareness of the situation [57]. This thesis takes Endsley's definition, where situation-awareness refers to the outcome [60]. Furthermore, Endsley states that situation-awareness, although distinct from decision-making, is a key input to the decision-making process [60]. Therefore, understanding how the mining IMT and IC form situation-awareness is essential if IMT decision-making is to be improved. If situation-awareness is accurate and can be acquired quickly, there is the potential for decision-making to be improved [228].

The process of acquiring situation-awareness, is generally perceived as a cognitive process requiring perception, senses, attention, comprehension, information integration and working memory capacity to detect and process the cues from the environment to form an understanding of the situation [61, p. 325] [151]. Situation-awareness is said to be affected by attentional issues, working memory capacity, long term memory, work-load and stress and that perception, spacial ability and analytical skills are key to the acquisition of situation-awareness [60, 73]. Therefore, the problems generally associated with poor situation-awareness are those that limit an individual's cognitive capacity such as being tired or stressed [191]. Situation-awareness has primarily been assumed to exist solely in the head of the observer [190] without acknowledgement of the observer-world interaction that is prescribed by systems engineering theorists [194, 195].

The key reasons why much of the situation-awareness research carried out in other industries cannot be directly applied to the mining IMT include that, firstly, most of the situation-

awareness research has been carried out on professions, like pilots or surgeons, who can directly perceive the data by scanning digital displays or by watching for a physical response. This is not the case for the mining IC who is solely reliant on information communicated to him/her by others. Secondly, the limitations identified by Endsley that impact the acquisition of situation-awareness are generally only cognitive and include the interactions between working, short-term and long-term memory and their experience. Thirdly, there is little account of the role of communication in the acquisition of situation-awareness, or, fourthly, how communication and situation-awareness may be affected by social processes that may arise from the emergency environment or the command and control structure.

To facilitate discussion of this topic, the roles of the IMT must be clarified within the industry. Despite the implementation of MEMS, this remains unclear. A variety of statements relating to the IC being wholly responsible, the ideal decision-making process being collaborative, and the need to stick to one's own roles in the Level 1 reports and MEMS training creates a confusing message. The Level 1 reports and MEMS training do not prescribe what takes precedence in an IMT meeting: hierarchy, collaboration or distributed responsibility i.e. the IMT members are responsible their own functional area but are aligned towards the same overall goal [18]. This is important in theory and practice because different methods of sensemaking are used in hierarchical and collective data gathering processes [105].

The IC is at the apex of the hierarchy, according to MEMS, and is solely personally responsible for the decisions made. Consequently, one would assume that he/she needs a complete understanding of the situation. Conventional situation-awareness processes would dictate that this means the IC should receive sufficient data to enable him/her to achieve personal situation-awareness to inform his/her decisions. However, in MEMS, the IC is provided with a group, the IMT, to work with collaboratively to assist the IC make or approve decisions. The idea behind this is to help the IC make optimal decisions by benefiting from the information, skills and experiences the IMT members have. The team-members analyse the raw data outside of the IMT providing the IC with richer information and lessening the likelihood of the IC becoming overloaded [132]. However, their involvement suggests the decision-making is a team effort, and if it is collaborative, some level of shared situation-awareness is necessary if they are to assist the IC make critical decisions.

This is in contrast to simply furnishing the IC with sufficient data to make decisions or simply chipping in on decisions relating to their functional area. A collaboration where the IC is solely responsible seems inconsistent. It means the team's involvement may not automatically augment the ICs abilities because their role is unclear. Are they a collaborative team with the equality that assumes? Do their responsibilities only extend as far as the boundaries of their functional area? Or, are they working in a hierarchy and doing what they are told? These situations are very different and elicit different social interactions. For example, it is well recognised that those who are more junior or who have less status may be reluctant to speaking up in a team [58], and if a team member feels he/she is accountable for his/her functional area

alone, he/she will be less inclined to exert effort understanding information to assist the IC if the overall emergency management is the IC's sole responsibility [182].

Unlike the non-technical skills literature, where the focus has been individual processes only [73], it seems important to understand the processes an individual and a team use to acquire situation-awareness because both may coexist in a mining IMT. The following paragraphs will describe the individual cognitive processes involved in acquiring situation-awareness and then the social and cognitive processes involved in forming team situation-awareness.

Individual Situation Awareness

Endsley's work remains relevant to the mining IMT, because each IMT member, including the IC, will form some understanding of the situation by cognitively processing existing schemata from their long-term-memory alongside the information they acquire during the incident to develop a mental-model of the situation. This internally focussed cognitive process is only one small part of a broader process. Endsley would not define the broader process as situation-awareness, but it is essential to the development of a mining IC's and IMT's situation-awareness in real-life. The individual cognitive processes of acquiring situation-awareness (Level 1 through to 3) will occur, but the data sources will be different from those assumed in the majority of the literature, and they will be different for each IMT member and the IC. The IMT members may have closer access to raw data (such as gas monitoring data) meaning that they must gather data in what could be termed a hybrid-environment [138] where they must recognise the situation from a mixture of communication and technology. However, the IC only has the information that is communicated to him and this occurs in the IMT meeting itself. In this environment the information will be a rich mixture of the facts, experiences, understanding and interpretations each team member has made regarding some or all facets of the incident being addressed. The information will not be isolated from the social interaction that occurs in that meeting and the pressures the emergency environment places on this interaction. Therefore, the data source for an IC, and for IMT members trying to augment their mental-models with information from their team-mates, is a rich but interdependent and complex amalgamation of facts and feelings shared by communication.

The acquisition of situation-awareness has often been defined in linear and deterministic terms [195]. However, as with the problems that arose with assuming decision-making was a methodical and analytical process, researchers struggled to explain how people could make rapid predictions [195, 194]. An example of this is a fire fighter who knows he needs to get out of a room and escapes just in time before it collapses, yet he cannot articulate why he knew he must get out. Such examples indicate the potential subconscious nature of experts situation-awareness.

The construction of situation awareness as potentially sub-conscious is at odds with an engineering definition of situation awareness that 'good situation awareness implies a high correlation between actual and judged system states' [100, p. 463]. The engineering approach

views situation-awareness as the observer's knowledge of an amalgamation of facts about something external to the observer; that is, situation awareness is something factual and driven by the world and the things in it [196]. This understanding assumes there is an objective truth independent of the observer.

This construction seems superficially logical because some data are factual (such as methane levels) and it may appear that these facts alone can provide all the information needed to determine the appropriate actions to take without requiring any subjective interpretation. However, this is too simplistic in the majority of cases because data is frequently missing or can be interpreted in a number of ways. Situation awareness therefore requires interpretation of data, and is the outcome of an interaction between conscious and sub-conscious cognition and the data obtained from the environment [190].

Situation awareness is not simply about the acquisition of all relevant and objective facts. As with all knowledge, it is constructed by people. No two individuals will construct exactly the same understanding of a given situation because of their different experience [190]. Situational assessment is neither passive observation [190] nor simply the acquisition of the data. It is the individual's perception of the meaning of the data and what the individual predicts it means for future events.

This interaction between the individual and the environment is understood to be dependent on the use of schematas that experienced individuals have stored in their long-term memory from previous real-life or simulated experience [60]. The mental-models they use are prototypes rather than a representation of an exact and detailed situation and can therefore be applied to different situations with similar attributes [60]. The cognitive processes involved in using mental-models to achieve fast and accurate situation-awareness include pattern matching, where an experienced individual recognises the situation by using stored memories of a similar situation [228, 199], and, assimilation and accommodation, to integrate new information into what is known [24]. Therefore, it is vital that the observer can adapt and update his/her mental-model [208].

These mental-models facilitate the acquisition of situation-awareness by guiding the data search (Level 1 situation-awareness), understanding the information that is returned (Level 2), and using this understanding to predict what might happen next (Level 3). This makes sense theoretically, but in the real world, the process of acquiring and understanding the data, on which the situation-awareness will be based, is not going to be as linear as the three level approach suggests. The individual is likely to receive data that cannot be understood in terms of mental-models, some data may not be available at the time it is required, other data will be inaccurate or incomplete [101]. The IC must instruct others to look for more information if it is needed, meaning that sufficient data to form enough of a whole picture (mental-model) is required to enable the determination of what information might be missing. Experienced incident controllers in other industries are said to be able to determine if they are losing the big-picture suggesting that 'Situation awareness not only supports the construction of 'the picture'

but also assesses its integrity' [190, p. 64] highlighting that situation-awareness is more than the linear and deterministic cognitive process often described. Situation-awareness is actually a cyclical and iterative process of taking action to look for information which instigates further action to acquire more knowledge [195].

However, there is a fine line between conducting a guided information search, which is said to be essential to acquire situation-awareness efficiently, and potentially biasing situation-awareness by not considering all the relevant data or misinterpreting it. Problems can occur if the observer has no mental-model, their memory fails them, they are over-reliant on their mental-model and fail to look for data that may prove their mental-model incorrect, or if they select an irrelevant mental-model and only seek data that fits this model resulting in confirmation bias [60, 195].

In summary, when an individual receives data, it will be processed cognitively in an effort to understand the situation. In the situation-awareness literature, this data is expected to be directly perceived by the observer i.e. he or she 'sees/hears/feels/smells/tastes the whole experience in terms of its meaning' [194]. However, the mining IC's raw data is communication from others. IMT members will obtain data from communication with their own functional teams and possibly some raw data, but they are reliant on their incident management team-mates and each of their mental-models, skills and experience to achieve situation-awareness of the incident as a whole if they are to collaborate with the IC and assist him/her with decision-making. Therefore, a large proportion of acquiring situation-awareness requires a sharing of some, or all, of the situation-awareness between the IMT members and between the IMT members and the IC.

Team Situation Awareness

Team situation-awareness is more than simply the cumulative situation-awareness of each team-member [157], but there are three different philosophies regarding what team situation-awareness actually is, and how much is optimal. The first philosophy considers that the ideal team shares situation-awareness, meaning that they all have similar situation-awareness around certain aspects [60], the second considers that having shared situation-awareness is impossible given the reliance on an individual's knowledge and experience to develop their situation-awareness. This means that situation-awareness is 'distributed' and team members only know what they need to know about their own areas, and as long as it is compatible with the others' this is adequate [195, 99]. Most recently however, it has been considered that a combination of these two philosophies is most likely to be beneficial [25].

In any case, some shared, or at least compatible, situation-awareness within the group is desired and this involves a process of sense-making. In a team, this involves synthesising one's own mental-model with respect to others' [105]. This process is wholly dependent on communication in the IMT. To share mental-models team members must share a broad mixture of fact, interpretation, feelings, and evaluations based on the information available and their own

experiences. The transference of such rich data is far more complex than the simple transmission of data from one person to another and is part of the process of achieving sufficiently compatible mental-models on which to progress the development of the team's situation-awareness and the IC's situation-awareness [99]. Consequently, the environmental and team factors that can impact communication become an inherent part of the process of developing situation awareness and making decisions, yet this has received little recognition in the situation-awareness literature [17].

For the IC to benefit from the team's technical skills, and their interpretation of the situation, the IC must understand the rich information they can provide, not only gather facts. The IC would become overloaded if he/she were to receive all the technical raw data to process, therefore the IC must rely on the team-members to process the data and present an informed interpretation. This means the IC must develop a mental-model that is aligned sufficiently with the information provided to fully comprehend the message.

Shared mental-models are needed to maintain tactical understanding of the operation and the functions of the team-members [62]. However, in command and control, the overall hierarchy places the IC in charge of the whole event, meaning that the IC needs an understanding of the people involved, the broader teams and the responding-agencies which means that he/she must maintain a more overarching situation-awareness than the team-members to coordinate the teams and predict others' needs [6, 155]. Essentially the IC is trying to maintain situation-awareness over a number of environments [219] and maintaining this additional level of awareness means additional demands on his/her cognitive resources [6]. It is recognised in other industries that it is unrealistic to assume one individual is capable of managing a large incident [6].

2.3.2 Communication

Communication is an integral part of forming mental-models that are compatible with teammates [157]. Therefore, communication is critical to developing team situation-awareness and thus the decision-making process. In previous non-technical skills literature communication has been recognised as an element of all other non-technical skills rather than being a skill in its own right. Communication has been viewed as a transaction between a sender and receiver [126]. Meaning that a message is encoded, transmitted and then decoded by the receiver to access the meaning [73]. Thus tactics to improve communication have been based on making sure the message is correctly transmitted and received. For example, the implementation of two-way communication where the receiver recodes the meaning taken from the transmission, and transmits it back to the original sender to check the meaning.

This aligns with the strategies previously adopted in mining. Mining researchers have developed the 'emergency communication triangle', which identifies three primary categories essential for the communication of an incident: who, where and what [127]. And if circumstances allow,

the secondary categories of miners, event and response should be transmitted [126]. However, the message itself is only one aspect of getting communication 'right' during an emergency: 'the right information needs to get to the right person at the right time' [157, p. 478]. Four common communication failure mechanisms have been identified; the information comes too late, the content is incomplete or inaccurate, the information does not reach the key individuals or issues are ignored until they become urgent [157].

Notwithstanding this, defining the 'right' information is essential. The information must be accurate because a wrong decision based on faulty information may be irreversible [113]. The transmission of numeric facts or data may be adequate in some cases but frequently more is required of communication than the receipt of data or facts if it is to support team-cognition and create team knowledge [99]. The role of communication in the IMT is to achieve shared meaning to ensure that the other person can understand the meaning in the words/data/information/instructions [32]. Thus, communication is a critical component of building team situation-awareness [157].

However, the communication process may be more complex in a mining IMT than has been identified in other industries. Mining research has highlighted that during an emergency response, miners use 'who' the information has come from as a determinant of its accuracy [126]. The information giver's experience, whether or not they are trusted and credible dictate how 'right' the information is perceived to be [113]. This indicates that the message the receiver takes from information transmission is more than the facts alone. These miners are using the context surrounding the message, specifically in this example, who delivered it, as a component of the message they receive.

The IC's and IMT's mental-models will be negotiated, explicitly and implicitly in the IMT. Discussions will create meaning around the data and this meaning will guide the development of situation-awareness [25]. How the information is presented during these discussions will influence how the team-members assimilate and accommodate the information into their own mental-models [6]. What a team-member says in the IMT is shaped by the individual's mental-model. In turn, what is said, is used by others to shape their mental-models and then what they say will be based on their mental-model. This iterative process occurs until all team-members mental-models become similar [98], or at least compatible enough to move forward [99].

Accordingly, in addition to factual transmission, what team-members say is critical to the development of situation-awareness [228, 206, 157]. Information that is known by multiple team-members will automatically be discussed more in the IMT than information that only known by one team-member [9]. This means that how the individual imparts this information is important. For example, using the same words as others in the group can support the development of a shared situation-awareness [195]. In addition, social aspects such as trust, honesty, self-respect and the norms of respectful interaction are also said to make groups better at the sensemaking process [218] because when people become agitated they concentrate on this rather than the task [217]. Additionally, team-members can adopt the mental-models of others

without synthesising them with their own skills and this, along with some people's tendency to go with the majority [9, 205], can result in the teams' situation-awareness becoming aligned without much analysis resulting in team-biases such as groupthink [25]. Deviance tactics, such as the implementation of a Devil's advocate, can be effective in alleviating this [170] but can also lead to conflict issues [198].

Hierarchical structures such as MEMS assume that defining information flow helps decision-making and in some cases this can be true [6]. However, problems occur when communication up and down is inadequate and what is communicated is based on what people think those on other levels of the hierarchy need, rather than what they actually need to know [141]. Team members may filter out too much data making it difficult for the IC and other IMT members to pattern match, detect inconsistencies and know what data is missing. Alternatively, they may fail to pass on information because they believe it is inconsistent or irrelevant, yet it may be a vital clue. Good communication outside of the IMT is also essential because any omissions, miscommunications, ambiguity or errors can infiltrate the IMT via its members.

Flin et al (2008) proposed four generic aspects of good team communication; being explicit to avoid any ambiguity; timing the communication appropriately; being assertive; and undertaking active listening. Ambiguous information is problematic because it can lead to multiple interpretations. If ambiguity is not recognised there is a risk that the receiver could falsely assume that their interpretation of the information is the only correct interpretation [153] or feed biases [228]. Ambiguity may also contribute to plan continuation errors because without concrete evidence to support why something doesn't feel right, or doesn't match one's own mental-model, there may be a reluctance to speak-up [153].

Not speaking-up was an issue identified by the non-technical skills literature. On the flight deck it is the leader's responsibility to 'establish the social climate in which crewmembers are encouraged and expected to provide and receive information' [92, p. 125]. The communication climate in an aircraft is developed by the pilot briefing [153], and in swift starting teams, the tone of the first few moments establishes this [227]. Behaviours that can reduce the likelihood of people contributing include being treated in a rude manner [209] or being challenged too directly [153]. ICs who interacted more with their teams than others were found to perform better, indicating that the environment the IC creates is a key factor in determining the quality of communication in an IMT [6].

Other reasons for communication failing in an emergency environment, include information overload [73]. This means messages may not be heard due to the overload or the accompanying stress, as people focus on their tasks rather than listening [172, 69]. Communication and trust are reciprocal and are both required for good team communication [172, 82]. Emotion, stress and mood can impact communication [160] with stress and emotion often leading to data filtering either unintentionally but also intentionally. Team members may be reluctant to pass on unfavourable data and emphasise good news, or they may alter information to make themselves look better or filter the data more as time pressure increases [136]. This filtering of

the data means that decision-makers are potentially accessing inaccurate or incomplete data.

2.3.3 Leadership

The activation of MEMS in the event of an emergency clearly places the IC at the top of the command and control hierarchy. MEMS states the IC takes sole responsibility for the 'entire response' [178, p. 7]. It is perceived by the Queensland mining industry, and was restated by the Pike River Royal Commission, that the mine-manager will assume the role of IC in Queensland, and according to the Coal Mining Safety and Health Act the mine-manager has the statutory responsibility for the mine and all who enter it [40]. Therefore, it is clear that in the event of an emergency, the mine-manager is a critical actor.

Incident control systems are usually implemented in industries where the IC is an experienced emergency decision maker such as the military or the emergency services, where skills in making decisions in dynamic, time-pressured and high-risk situations are developed through extensive training and practice in real-life or in realistic simulations. However, mine-managers only have limited relevant training and experience: they must only satisfy one relevant unit of competency within their training; the MEMS course is not mandatory and is a one-off; multiple fatality incidents are rare; Level 1 exercises are annual and only occur at one mine per year; and the mandatory annual simulations at mines are less rigorous than the Level 1 exercises.

Mine-manager training does not extend beyond the physical preparation and organisation of a documented system; 'Establish and maintain underground coal mining emergency preparedness and response systems' [37]. The three critical elements of incident control, identified by Flin from extensive studies in incident command, are not addressed. These are the social skills to manage a team under emergency conditions, the individual's ability to cope with stress and the skills to make decisions under these conditions [68]. The only non-technical skill included in the mine-manager qualification is the requirement to have knowledge of decision-making processes. However, this requirement is very different to assessing the candidate's personal capacity for decision-making under conditions of extreme stress, whilst managing the teams, the assistance agencies, mines rescue, assistance from other mines, the media, the families, the police, the mines inspectorate, the government, politicians, and head office i.e. the reality of being an IC during a serious mining incident.

The philosophy of using the most senior person on-site as an incident controller is not unique to mining. In other high-hazard industries this is necessary because the emergency services cannot be relied upon in their usual capacity due to the remoteness of the site, as is the case for offshore oil and gas rigs, or due to the complexity of the industry, as is the case at nuclear power plants. In this respect, the role of mine-manager is very similar to that of an offshore installation manager. They are production oriented on a daily basis and become the IC should an incident occur [45, 74], yet 'cannot be said to be expert emergency managers' [186, p. 145]. In both cases, those who become ICs are there because of their rank in the company,

not because of their emergency management skills [68].

The devastating consequences of assuming offshore installation managers had the inherent characteristics to become a competent IC became apparent on July 6 1988, when the Piper Alpha North sea oil rig exploded killing 167 people. The Lord Cullen report, an investigation into the tragedy, highlighted the potential deficiency of having an IC that was not selected, trained or necessarily made of the 'right-stuff' to be an IC (Lord Cullen's report 1990, as cited in [76]). This report instigated an intensive research program to identify the skills and traits required of offshore installation managers as ICs and how to improve their selection and training accordingly [75]. The search for the 'right stuff' precipitated research looking at the ideal personality traits for an effective IC. Better performance was moderately correlated to liking to take charge, being sociable, tending towards making fast decisions, preferring abstract thinking, and liking to analyse the behaviour of others [189, 187]. They also found that communication and decision-making factors accounted for 70% of the variance in performance [74]. However, overall the personality indicators were not significantly correlated with performance [76, 68].

Ultimately, the focus on personality could, at best, help the industry to 'select-out' those mine-managers that are less likely to perform well as an IC, as is the case in aviation and military, but the focus on personality does little to improve the skills of personnel. Therefore, the focus on personality has generally been superseded by research addressing required skills, because these are more accessible by training [59].

Since Piper Alpha, the selection criteria for offshore installation managers has been reviewed [188] and competencies have been developed for assessing emergency management ability [186, 68]. At least one employer has developed training and selection criteria to identify offshore installation managers that are 'competent' or 'not yet competent' in emergency command (p67, D113). Table 2.1 lists the competencies identified. The determination of competency is based on extensive training involving a week long emergency command skills training course, several on-shore table-top training exercises, a major offshore incident simulation, and finally an assessment based on another major offshore exercise. Throughout the process the offshore installation managers are required to address the extensive feedback provided by a selection of Royal Navy personnel and experienced ex-offshore installation managers who have also received training (a summary of this process is provided in [68].

Leadership ability is a key component of an IC's necessary skill set [75]. Yet the term 'leadership' is generally broad and unhelpful. In the words of Pondy, 'Have we been misled by the existence of a single term in our language to think that it reflects some uniform reality?' [163, p. 224]. 'Leadership' means different things to different people and at best captures a wide range of loosely related features. Statements such as the following, which is included in AIIMS: 'the need to be capable of using sound leadership and managerial practices to implement their strategies in the safest and most efficient manner', explain nothing [65, p. 36]. CIIMS is slightly more detailed it states 'an effective Incident Controller must be assertive, decisive, objective, calm, and be a quick thinker ' and 'also needs to be flexible and realistic about his or her

Table 2.1: Performance criteria for offshore installation managers

Ref.	Criterion[a]
1	Maintain a state of readiness
2	Assess situation and take effective action
3	Maintain communications
4	Delegate authority to act
5	Manage individual and team performance
6	Deal with stress in self and others

[a] The six performance criteria for OIMS, as cited in [186, p. 127]

limitations' [26, p. 15]. However, there is little supporting research for statements such as these.

Incident command researchers state that a leader in daily operations needs different skills to that of an IC, and that traditional management techniques are irrelevant and potentially detrimental to an emergency response ([115] as cited in [73]). Evidence suggests that leaders' behaviours change as a situation becomes an emergency including communication patterns [192] and decision-making processes [156]. Leaders in daily operations generally make objective and consultative decisions whereas, during an incident, an IC tends to make subjective and directive decisions ([115] as cited in [73]). This is in line with experts using intuitive methods to make decisions quickly enough to be useful. The study of offshore installation managers revealed that they were no exception to this and ultimately did not use the processes taught and promoted by their industry [186].

It has been recognised that an IC's interpersonal skills determines their effectiveness [52]. Such skills are said to include 'communication, flexibility, team-working, high-level decision-making under pressure, and stress management' [68, p. 46]. Managing one's own and others' stress and understanding how it impacts decision-making appears critical. Stress and emotion are discussed in a later section of this report, but it is essential to highlight the specific stressors the mine-manager in the role of IC is exposed to, as an individual, within the current Queensland emergency management system.

Unlike ICs in most other industries the mining IC is unlikely to have experience in anything similar since there has been no multiple-fatality incident in Queensland for twenty years. Therefore, a mining IC is bound to feel more stress than experienced emergency commanders simply because he/she will have had little exposure to the emergency environment [68]. Further, unlike the emergency services the mine-manager has no alternate to take-over at the end of a shift. A mine-manager in the role of IC is solely legally responsible for all decisions made during a mine emergency due to his/her statutory responsibility in section 150 of the Coal Mining Safety and

Health Regulation [39]. The IC is therefore personally culpable for any poor decisions whilst retaining control of the mine, whether or not he/she is physically present or not. From a legal perspective it is understandable why the industry seeks this unified command approach, but it may be detrimental to IMT performance [119]. The accountability placed on the IC will undoubtedly contribute to the IC's stress levels [90, 89] because the IC will have to deal with the legally assumed guilt and potentially fear the personal repercussions including individual prosecution and the cost to career and personal reputation.

The hierarchy prescribed by MEMS may provide some sort of comfort to others, the 'security promised by a commanding leader" [215, p. 138], but this is misguided because the IC is most likely to be inexperienced at managing an emergency. Furthermore, the hierarchy may result in team-members shedding their responsibilities onto the IC, because the IC is of higher status [36]. Task shedding is a common tactic used to cope with stress and is likely to occur because team-members may also feel under pressure [108, 90]. The relationship between the IC and the IMT is critical to successful leadership. Without followership, leadership is ineffective [87]. Therefore, factors that determine the relationship between the IC and IMT members are critical to the success of the response.

2.3.4 Trust

Trust is an issue that has rarely been raised in non-technical skills research, but when it has, it has been included as an aspect of teamwork. However, trust has received significant attention in mining literature [113, 111, 82] and therefore seems worthy of separate consideration for the mining IMT. Trust issues were identified by the NSW mining industry safety review as a critical factor in determining health and safety outcomes [223]. However, worryingly "debilitating mistrust" [82, p. 19] was identified as one of the "industry systemic issues" [223]. A subsequent report commissioned by the Australian Coal Association Research Program noted 'mistrust is deep-seated at a number of mines' [82, p. p4].

The 2008 report noted that a lack of trust has seriously impaired the ability of mine management and mine workers to work together, 'the industry has a history of antipathy and antagonism between workers and management (an us and them attitude prevails)' [82, p. 19]. Reciprocal mistrust was noted between mine management and mine workers; mining companies and the NSW mines inspectorate; trade unions and mines; mine-sites and their corporate management; contractors versus staff employees; and long-term workers versus short-term workers. These divisions and cliques were described as a 'prominent feature' of the NSW mining culture at the time of this report [82, p. 47]. The tendency not to report issues to mine management, deliberate non-communication between groups and widespread suspicion outline in the 2008 report could seriously impair IMT performance.

Trust has been highlighted by miners with experience in emergency conditions as necessary to get people to accept instructions and information [211]. Miners have stated that the IC must

be trusted by both escaping miners and the incident command team, especially in the early stages of a response [113], and mining emergency decision-makers have indicated that they rely on trusting those who provide them with the information they base decisions their on [113].

The identification of such inherent mistrust in the industry, combined with statements regarding its necessity in emergency situations, is concerning because trust issues could potentially worsen in an emergency. Mine workers trust in mine management decreases the more management isolate themselves from the workers and also when workers feel that they are not being heard [82]. The workers may perceive the formation of an IMT as doing just this. Secondly, the deep-seated mistrust of the mines inspectorate has developed from the expectation of routine prosecution for those who are in charge if a fatal incident occurs leading to the perception that accident investigations are actually 'de facto prosecution investigations'[82, p. 5]. During an incident, such concerns are bound to increase, especially for the mine-manager.

Two types of mistrust were identified in Australian coal mines; motivational mistrust and a mistrust of capabilities. Motivational mistrust refers to the belief that another person is acting in a self-serving manner to the detriment of the team and is believed to be the most disruptive because it leads to the breakdown of relationships. A mistrust of capabilities was defined as the belief that the other person or team may not have the capabilities to perform what is expected of him/them, but this is easier to resolve because it is related to capabilities rather than motives [82].

There is no universally accepted definition of trust and it is a "nebulous concept" [193, p. 1] but often involves a notion of vulnerability [36, 194] i.e. the truster adopts a position of vulnerability or risk with the understanding that the trustee will act in the truster's best interests. In a mining IMT the IC cannot do everything alone so must trust the team to act in his or her best interests because it is the IC who is personally vulnerable if things go wrong. In other words, the IC must accept the personal risk of delegating his/her fate to the team; this is trust [134]. The more the IC trusts, the more he/she can benefit from the group's collective skills [41].

Trust can directly influence the amount of information shared because, in the worst case, individuals or cliques at mines that do not trust each other can refuse to speak to each [82]. Further, a lack of trust in the mines inspectorate has meant information sharing by the mine has been hampered by a fear of self-incrimination [82]. Therefore, with more trust, more information is shared [88]. Interestingly, the reciprocal is also true; sharing more information builds trust [134, 88].

Studies on trust in emergency response are 'scant' [88], however trust is imperative to good teamwork [227, 153, 213, 68], performance [172], and enhanced group decision-making processes [53]. Without trust, collaboration becomes difficult; work is unnecessarily rechecked, people work independently and fail to delegate [53]. Often team-members become distracted by trust issues, such as evaluating others' behaviour, limiting the cognitive capacity available to focus on the team goals [33, 134]. Mistrust can cause the collapse of sense-making [88, 25] and mutual

trust and respect are believed essential to the success of an IMT [69].

Where there is mistrust collaboration can fail because people behave in a manner that is not conducive to teamwork. Having trust can protect against collaboration failing because if someone behaves in an unexpected manner due to an emotional reaction to the emergency environment, and they are trusted, their behaviour is less likely to be deemed offensive or suspicious [41]. Pre-existing trust is not influenced by new emotions [56]. When trust has been established prior to team formation, it is retained during an emergency. However, this can be detrimental if the trust is misplaced, especially in a technical environment because it can lead to assumptions being made that certain technical processes or tasks have been actioned when they may not have [205].

However, if the IMT is formed quickly, and some individuals are unknown, they have to presuppose trust because they do not have time to earn it. It is proposed that this is more of a 'role' trust than a 'person' trust [134]. Over time, trust can be established but a person's mood can affect how much they trust someone [193] and when they are emotional, their evaluation of who to trust or how much to trust can be affected [56]. Angry people tend to trust less than sad people [56], highlighting the potential vulnerability sad people may expose themselves to in a serious incident or alternatively how angry interactions may escalate in a low trust environment.

2.3.5 Teamwork

The typical definition of a team used in non-technical skills research is 'a distinguishable set of two or more people who interact, dynamically, interdependently, and adaptively toward a common and valued goal/objective/mission, who have each been assigned specific roles or functions to perform, and who have a limited life-span of membership' [173, p. 4]. However, the mining IMT is quite different to this team. Firstly, the IMT is structured hierarchically and team-members are working in pre-defined roles and responsibilities, but these are not the same as their daily role. Secondly, those in the team may know the other team members but be unfamiliar working with each other in these roles. Thirdly, the seriousness of the incident may mean other agencies become involved, and lastly, the team is working within an emergency environment which is unfamiliar to them. The IMT therefore involves aspects of many different teamwork research fields and also branches into the emergency management domain. In terms of teamwork, the mining IMT could be described as a swiftly formed and ad hoc emergency response team within a 'team of teams' [227, 174] where information is shared 'within and between teams, up and down a chain-of-command' [12].

The most illustrative way to describe team-working in the IMT is possibly to explain what it is not. It is not the MEMS system and it is not the task-work. Task-working relates to doing the tasks without consideration of the team [23, 174, 172]. Teamwork refers to the social processes that are needed to make a group of people come together as a team, or even a team of teams

and includes the many social and cognitive issues that can impact team-members interaction. Salas et al describe teamwork as 'a set of interrelated thoughts, actions, and feelings of each team member' [172, p. 562] and includes aspects such as making people feel valued to encourage their contribution [172], it is reliant on trust [172, 227], it is about how people feel about each other and the task [73], yet the goal of 'teamwork' is not increasing the harmony in the team it is about how to make better decisions [27]. Teamwork supports decision-making by taking advantage of combined skills and knowledge, as described in the situation-awareness section, and provides a mechanism to catch errors and provide back-up strategies such as monitoring team-members for the effects of fatigue or stress that could impair their performance [153].

Coordination is one of the critical social processes required for teamwork [174], and requires an understanding of others' roles and responsibilities [7]. This, when it becomes implicit rather than explicit, can speed up performance as team members can anticipate others' needs and react earlier [7, 27]. Implicit coordination and the ability to read others relies on shared mental-models about the team and the roles (in contrast to that of the incident) [27] and may be reliant on the team forming an identity [73]. The most effective teams are those that can alter their behaviours, workload, processing and communication to suit the situation [152].

Collaboration is also required and relies on cooperation [172] but this can be hampered by individual's seeking to satisfy personal tasks rather than group goals [4], a tendency which is more likely in inexperienced teams [73]. Collaboration and cooperation are necessary to distribute workload fairly [216], yet pure collaboration is rarely achieved, even in the emergency services [4]. It seems especially unlikely within the mining environment characterised by 'antipathy and antagonism' [82, p. 19] or within the constraints of an ICS, "Greater capacity for command and control is not synonymous with greater capacity for collaboration" [215, p. 137].

The cliques that are a "prominent feature" of low trust mines, and the 'us-and-them attitude' between workers and management leading to groups not speaking to one another [82, p. 19] have the potential to undermine the effectiveness of a mining IMT because the IMT is reliant on communication from mine-workers for information to derive their situation-awareness. Additionally, conflict in the form of rude behaviour has been shown to reduce helpfulness, disrupt cognitive processes and impact task performance of the recipient and the team [164].

Ultimately the mining IMT, needs to be effective immediately, even if there is no social scaffolding to work with. Swift starting teams are said to be more task-focussed and the social needs of the team members are of lower priority [227], and it would be fair to assume that this would be the case in a mining IMT for pragmatic reasons. It is also what the duty card system and MEMS promotes by the pre-definition of roles and responsibilities.

The component elements of teamwork are less obvious, and as recently as 2005 most researchers were left wondering, 'what is teamwork?' [172, p. 558]. The response was the development of the 'Big Five', the core components of teamwork; team leadership, mutual performance modeling, backup behaviour, adaptability, and team orientation [172]. These require mental-models, mutual trust and closed loop communications as coordinating mechanisms

[172]. Teams are more likely to be effective if they have a shared situation-awareness of the task, the task environment and the roles and skills that other team-members bring to the team, thus highlighting the integrated and reciprocal relationship between the non-technical issues discussed in this research.

2.3.6 Emotion and Stress

In response to questioning by the Pike River Commission, the police resource-coordinator indicated a belief that emotion impairs decision-making, and implicitly, that "objectivity" is both possible and desirable in such situations:

> *'you can't afford to have that sort of variable [emotion and fatigue] impacting upon your decision-making, so you lift it up to have a degree of objectivity to ensure the best available information is providing and contributing to the decision.'* [204, p. 1727].

One of the major criticisms surrounding the rescue and recovery at the Pike River mine was that the decision-making approval process was taken from the mine-site and delegated to police officers in the town of Greymouth and at police headquarters in Wellington, NZ [203]. The police justified this strategy by claiming the need to distance decision-making from the emotion and fatigue inevitable at the mine-site.

> *'So as the response co-ordinator, fundamentally I set the strategic framework and that's been documented and is available to the Royal Commission. I set it out determining the decision-making process and invest the decision-making with a degree of physical and emotional separation.'* [203, p. 1638].

> *'This was always going to be a challenge in this type of operation when people were involved in the rescue of those whom they worked with and knew. Fatigue was always going to be an issue, to be able to sustain the operation over a long period of time. So when you put emotion and fatigue into one context you've got a real cocktail of challenges. So you try and manage that by either sound structure or process, a combination of both actually.'* [203, p. 1639]

The consequence was that decision-making was removed from the mining company staff and other mining experts who had gathered at the mine and who were the most technically competent to contribute to the decisions. In any mining incident, those who work at the mine will be best placed to inform decisions from a technical perspective. They will also potentially be those most emotionally affected by it. However, the situation at Pike River highlights the short-sightedness of eliminating highly skilled personnel from making decisions simply because they may have emotions that could affect their decisions.

It is clear in the decision-making literature that emotion is an integral part of decision-making, whether we are conscious of it or not [137, 114, 13, 124]. However, the belief that emotion cannot be anything other than debilitating to effective decision-making is common in many industries [114, 197] and is highly prevalent in mining. The frustration and delays experienced at Pike River suggest that it is not possible to eliminate emotion from decision-making, even if it were considered to be desirable. This raises a few questions. What actually is emotion? Where does stress fit in? How can emotion influence decisions? And, most importantly, is it even possible (or desirable) to cut emotion out of IMT decision-making?

What is emotion?

> *'Emotions are not appraisals, but a complex organised system consisting of thoughts, beliefs, motives, meanings, subjective bodily experiences, and psychological states, all of which arise from our struggles to survive and flourish by understanding the world in which we live.'* [118, p. 100]

Emotion is a personal evaluation of one's involvement in the person-environment interaction. The environment includes the social world and the people in it. Emotion is not a fact, it is not defined by what went wrong or the stressor itself, it is the person's own evaluation of their situation that results in an emotion. Therefore individual differences are expected and personality can impact the emotion felt [118]. Making an evaluation of the emotion someone 'should' feel, and the resulting cognitive ability they 'should' have is simplistic, and could ultimately be to the detriment of IMT decision-making if individuals who can cope and are removed, or who cannot cope are retained.

Lazarus' list of fifteen emotions includes anger, envy, jealousy, anxiety, fright, guilt, shame, relief, guilt, hope, sadness, happiness, pride, love, gratitude [118]. Mining IMTs are not immune to emotion [110], and scenarios that could instigate all of these emotions could occur during a mining emergency management operation.

Where does stress fit in?

The existing mining literature has acknowledged that stress is a critical factor in mining emergencies [110, 111], yet also notes it has mostly been overlooked in training [109]. Lazarus proposed that emotion is the super-ordinate term that includes stress and coping and that emotion, stress, and coping are a conceptual unit [118, p. 37]. The coping process regulates the emotions that are felt and motivation and appraisal mediate them by influencing the evaluation of the person-environment relationship [118].

The definition that stress results from an evaluation of resources versus demands is well established [177], and because stress is an emotion, it is the individual's perception of this evaluation, rather than any objective measure, that determines their stress level. Therefore, stress is not necessarily directly proportional to the stressor, and the stress not the stressor

guides actions [109]. A moderate amount of stress is beneficial as this can activate a state of vigilance [90], yet too much stress can impair cognitive functioning [165, 116] or otherwise impact upon decision-making processes [171]. However, even the act of making a non-routine decision can induce stress [63].

The incident command literature outlines some of the stressors that ICs generally face during emergencies that can impact their decision-making. These include: inaccurate data, incomplete data, changing data, comprehending the information, differentiating fact from rumour, information overload, making and adapting plans, uncertainty regarding the severity of situation and the length of effort required, the media, the type of decision-making strategy being used, company procedures, level of authority, bureaucracy, time pressure, seeing the injured, multi-agency or inter-agency conflict and the consequences of error [45, 155, 158].

What could cause emotion in mining IMT?

A fatal incident is highly likely to trigger emotional responses. Initially, it is quite natural for people to deny there is an issue, feel numb and struggle to function cognitively [118]. An attempt to normalise the situation often occurs [131] and hope may be employed as a coping mechanism which may have been the case at Pike River where many perceived the hope was actually 'false hope' [161]. At Pike River, this hope quickly changed to sadness at the moment of the 2nd explosion. Sadness is different to other emotions because coping by re-evaluating the situation cannot work because sadness is a reaction to an irrevocable loss [118]. Compassion, described as being in-line with another's suffering and wanting to help can, 'paradoxically, can impair our ability to help.' [118, p. 246]. Uncontrollable events where people are at risk have generated the strongest stress reactions among rescue operation commanders [183], a situation that is unfortunately representative of a serious mining incident. The impact of traumatic stress has been acknowledged in the mining literature with a call to consider this in preparing for mining emergencies [111]. However, there are potentially many other emotions at play in a mining IMT that may be more subtle and less expected than those triggered by the horrific consequences to others.

The increasing criminalisation of human error can cause stress because personal goals such as not wanting to incriminate oneself may not align with the team's goals [50, 49]. This is particularly relevant to the mining industry where a fear of negative consequences is particularly strong [82]. Accountability can be serious stressor as can fear, anxiety, conflict and rivalry [90, 205].

Emotion results from the evaluation of the person-environment relationship. The environment guides what the person deems as acceptable and places demands upon the way people feel they should behave. Constraints include what is deemed punishable, time-pressure and culture [118, 205]. In many industries there is a culture to suppress stress [160] meaning social, cultural and organisational factors can contribute to stress [148]. The salience of the masculine and tough norms of the mining industry will also possibly contribute to IMT members'

evaluation of their own goals, beliefs and resources [118]. They may feel pressured to act in a particular way. For example pilots can engage in risky behaviours because they feel the social pressure to act as if they are knowledgeable even when they are unsure [153]. It seems highly likely that the masculine culture of mining, could impact how IMT members choose to deal with their emotion. For example, anger may be perceived as more acceptable than weeping but anger is even more disruptive because it increases the propensity to blame others and can cause conflict [56].

Anger results from the belief one has been unfairly slighted and it comes with social rules. In some cases anger is seen as OK or even warranted, but not in other cases [118]. Where anger has resulted from a 'demeaning offense against me or mine' [118, p. 217] saving ego can become the goal and result in relationship failure if the anger is not resolved [118]. Behaviours associated with anger, such as rudeness, can result in others becoming emotional if the target of the anger takes the behaviour personally. This may result in retaliation and further upset [198]; they may choose to end their social interaction with the person [164]; or they may waste valuable cognitive resources ruminating about the other person's behaviour [33, 53, 134]. There has been little research conducted on emotion in team performance [160].

How could emotion affect the decision-making in the IMT?

Emotion can directly impact the cognitive process of making a decision. Emotion that is related to the decision or its outcome, and emotion that the decision-maker brings with them to the decision-making process, that may be unrelated to the decision, can both impact the decision made [140, 133].

Emotion may be used as an input variable for the decision-making process, and this may actually be rational, albeit not in line with the goals of the IMT. The rationality may be in its alignment with the personal goals of the decision-maker. If there is personal fear related to a particular outcome, this may guide the decision towards avoiding this particular outcome even if it is not in the best interests of others [140, 139]. Decisions may also be made in a manner that minimises expected regret [35] which implies a personal anticipation element and an aspect of fear leading to self-protection [133, 176, 167]. It is also possible that emotion associated with the decision can result in avoidance of making the decision altogether [3]. This is deemed to be more of an issue when the decision-maker is aware he will be held accountable [182] and in a mining emergency environment, with the 'political pressure for mine-managers to be hung' [82, p. 24] the drive to do nothing may be extremely powerful.

Decision conflict arises when the decision maker needs to balance losses with their own self-esteem and reputation [89]. Their personal goals may not align with the team's. Guilt is a particularly influential emotion in decision-making because of the concern over one's own responsibilities [5]. Janis and Mann claim that when a dilemma involves serious losses and a decision is required in a short time period this is the scenario where 'thinking is the lowest of all' [90, p. 42]. This unfortunately describes the situation a mine-manager will find himself in

if an incident occurs at his/her mine.

The effects of stress on decision-making are well researched. Flin et al (2008) summarises much of the literature on the cognitive effects of stress by stating, 'the negative effects of acute stress on cognitive processes can be: over-selective attention (tunnel vision), loss of working memory capacity, restrictions in retrieval from long-term memory, with simple retreival strategies being favoured over more complex ones.' [73, p. 57]. Other issues include, reduced working memory capacity [108], a lack of concentration, over-reliance on rules, susceptibility to biases, flitting from one problem to another, an inability to prioritise, think ahead or work on multiple issues simultaneously [68], the tendency to provide an answer before weighing up all the alternatives, non-systematic scanning of information, temporal narrowing [96, 95] and getting side-tracked more easily [97]. When individuals are stressed, it is associated with a feeling of having lost control and it is common to try and redress this by finding an explanation for the situation to regain a perception of control [79].

In addition to interfering with the processing, emotion may also influence the types of decision-making process employed. For example a fearful and anxious individual may be drawn towards more systematic and comprehensive decision-making strategies [140] which are more impacted by affect [55]. When stressed or fearful there may be an under-reliance on intuition or when people are in a positive mood they may choose less effortful cognitive strategies [136]. Generally, when people are stressed they will stick with using more basic processes [227] and systems familiar to them [123, 85].

Emotion can also impact decision-making by affecting an individual's situation awareness. Emotion may impact the information collected by limiting and biasing the information search, or alter the interpretation of the facts because of a tendency to interpret information in a manner that makes it consistent with the observers mood [140]. Similarly, the observer's perception of the situation is dependent on an evaluation of the expected success of the operation [183]. This is significant because when leaders of real-life major emergency incidents viewed conditions as favourable a positive outcome was more likely [184].

Further, given that the acquisition of team situation-awareness is dependent on communication and team interaction, emotion that increases the likelihood of team disruption can negatively impact situation-awareness and decision-making. Emotional reactions can potentially cause behaviour that increases conflict which can, in turn, instigate emotion in others. Overt behaviours associated with emotion, and more particularly stress, that have the potential to cause emotive reactions in others, include aggression, hyperactivity, anger, argumentativeness, irritability, jumpiness, swearing, shouting and emotional outbursts [68]. Emotional reactions that reduce communication can directly impact upon team situation-awareness. These include freezing, withdrawing or becoming detached, apathetic, disengaged or focussing on retaliatory thoughts [68] and often result from personality clashes [205].

This means that the way in which individuals cope with their emotion can impact situation-awareness and decision-making. Although coping long-term following a mining incident is a

relevant and worthy topic of research it is not the focus of this thesis. Coping in this case means how people cope or deal with how they are feeling during the incident to enable them to continue contributing to the emergency management operation. Their coping mechanisms can in-turn influence the decisions that they make, and as explained above possibly influence others. Janis and Mann identified five coping mechanisms; vigilance, un-conflicted inertia, un-conflicted change, defensive-avoidance and hyper-vigilance [90]. The most efficient form of coping in terms of decision-making is vigilance. Extreme hyper-vigilance is often termed panic and does not normally lead to optimum decision-making in an emergency because of the associated constriction of cognitive capacity, perseverance and errors of judgement [90]. However, previous mining literature states panic is rare [129]. Also of interest is that hope is said to be required to maintain a state of vigilance [89].

Behaviours associated with defensive-avoidance coping include passing the buck to others either up or down the hierarchy of a command and control system or ignoring the unfavourable conditions of a decision they have made by bolstering the good points and ignoring the bad [90]. This behaviour is particularly dangerous because the person or team who has made the decision only focuses on the advantages of the decision made and dismisses any disadvantages meaning that they are unlikely to undertake decision monitoring or a realistic post-hoc analysis [3] and can fail to develop contingency plans [136].

One of the key issues the mining industry is likely to encounter, an issue identified in pilots, is a failure to accept that stress impairs their performance [76]. Previous mining literature has highlighted the benefits of individuals knowing their own stress reaction to enable them to continue to make decisions [113].

In summary, emotion (including stress) is the result of an individual's complex evaluation of their place in a complex social environment and therefore emotions are a product of reason. Emotions are based on personal reasoning at that time, and the situation can be re-appraised to modify emotions. The strong perception that to be emotional means to be irrational, 'a lack of regard for other goals is what highlights the idea that emotions are irrational' [118, p. 220], is untrue. The mine-manager's primary goal may be to avoid prosecution and therefore may act in ways to minimise this risk. This is not irrational, but others may see it as such because they do not share the mine-manager's personal goal. Furthermore, emotions are not unpredictable or necessarily guaranteed to negatively impact upon decision-making. Therefore, an honest appraisal of one's own, or others' self-interests, goals, morals and personal strengths and weaknesses may be more helpful than simply labelling all behaviours or decisions that do not align with the team goal as emotional and irrational. It must also be recognised that stress, in particular, can impact cognitive processing abilities and the way people behave, which may impact decision-making directly or by disrupting communication and team-processes vital for the acquisition of situation-awareness. An acceptance that it is impossible, and in many cases unwise, to eliminate emotion or intuition from decision making may be a more effective starting point from which to explore mining IMT decision-making.

3 Level 1 Exercise Reports

3.1 Introduction

Level 1 emergency exercises have been conducted annually in Queensland since 1998. Following each exercise a report has been published outlining the details of the exercise and providing recommendations for improvement. These reports have consistently called for improvements to decision-making in the IMT and most recommendations have outlined systems or procedural based solutions. However, the recurrence of IMT decision-making recommendations, even following the implementation of systems (including MEMS and MRAS), suggests that the issues that are detrimental to decision-making are not satisfactorily addressed by the current systems.

An examination of the Level 1 reports has indicated that the generic non-technical issues identified in previous non-technical skills literature may be impacting IMT decision-making. Table 3.1 below lists some comments made by Level 1 assessors that are indicative that non-technical issues may be equally relevant to the mining emergency response context. This chapter expands on this by examining the Level 1 reports in detail to understand the decision-making problems that have been identified and to assess the role non-technical issues may have played in them.

As a precursor to understanding the Level 1 reports, two issues that directly influence the content of the reports must be highlighted. Firstly, the Level 1 reports are generally written by assessors who are coal-mining personnel and are therefore not trained human-factors observers, or experts in the field of decision-making. Many non-technical issues, which cannot easily be observed, such as situation awareness, are naturally less likely to be included. Further, assessors generally only see what they are looking for. If the assessor focusses on procedural issues, as is likely given the nature of the industry, he/she may only recognise and make recommendations regarding issues that are believed to be amenable to procedural solutions. Further, even if the non-technical issues were recognised, the assessors may not appreciate the complexity and interaction of them, they may find them too difficult to articulate or they may simply disregard them as irrelevant and subjective.

Secondly, the Level 1 reports are written within the contextual constraints of the mining industry in Queensland. The host mines sacrifice significant sums of money, in some cases this has been millions of dollars, by halting production for a day to participate in these exercises. This monetary loss may drive the reluctance to be critical in Level 1 reports to ensure continued support from the industry for future Level 1 exercises. Since 2003 Level 1 reports have become much shorter than those published previously due to increased pressure to publish the reports soon after the exercises. As a result of these pressures, and the need to produce a document relevant to the industry not only the host mine, the critical evaluation of performance at the

Table 3.1: References to generic non-technical skills in Level 1 reports

Non-technical skill	Relevant quotes from Level 1 exercise assessors
Decision-making	Decisions not being recorded (1998, 1999). Not having a clearly defined decision-making process (1998, 1999, 2002, 2003, 2005). Groupthink evident (1999, 2002). Best with only core IMT members (2003).
Situation-awareness	Taking the initial decision/scenario or response as the only one and not considering all alternatives (1999, 2001, 2003). Failure to consider all the options available to them (2003). Being reluctant or cognitively unable to redefine the scenario to the correct one following an initial misinterpretation of the situation (2003).
Communication	Poor communications (1998, 1999, 2000, 2006). Better communications between CRO and IMT required (2001, 2002, 2008). Some communications not recorded (2002). Vital information for decision-making not getting to IMT (2005). Electronic communication went well (2007). IMT not challenging IC, more input from IMT required (1999, 2001). Informed the wrong family their next of kin was dead (1999). Information to IMT was slow and not of high quality (2000). Information flow needs to be improved (2005). IMT in the dark (2008).
Teamwork	Confusion regarding roles and responsibilities within the MEMS (2006). Rescue team not included in decision-making (2000).
Leadership	Goals not clear (1998, 2002, 2001). IC trying to set own goals (2003). Better objectives need to be set (2007). IMT needs to take control of all activities on site once formed (2010).
Stress management	Decisions are not driven to completion (2001, 2003).
Fatigue management	Fatigue affecting decision-making (2000, 2001, 2002, 2007).

mine has decreased significantly. The focus on providing industry wide recommendations means that authors avoid specifically commenting on poor performance. The recommendations are context-free and are a generic industry-wide recommendation based on the assessor's understanding of the problem and the strategy he/she feels could resolve the problem. However, given the assessors' inexperience with non-technical issues, the proposed solutions are not generally based on academic theory.

For example:

> *'Review training of statutory officials (and other personnel who may be required to lead in an emergency e.g. rescue personnel, leading hands) to include decision-making, leadership, communication and accounting for personnel.'* (2008)

This recommendation looks relevant to this research but actually explains nothing of the problem that prompted it. Its inclusion simply implies that inadequate performance was observed in decision-making, leadership, communication and accounting for personnel. The recommendation fails to recognise the complexity of the non-technical issues mentioned, and assumes that a revision of training can fix the undefined issues.

3.2 Method

Thirteen Level 1 reports were examined, those from 1998 to 2010. The three reports from 2010 to 2013 have not been included in this review because the researcher directly observed the IMTs in these Level 1 exercises. The reports each include an overview of the scenario, a timeline of the exercise and recommendations for industry. The average length of the reports is 84 pages.

3.2.1 Design

Hundreds of recommendations have been made since 1998, including over 150 solely directed at IMT processes. The recommendations are indicative of the methods the industry has implemented and believe should be implemented to address the decision-making problems. The recommendations were of limited value in detecting the role of non-technical issues because they did not describe the issue that instigated the development of the recommendation. As a result, the text and observations, rather than the report recommendations per se, were more illustrative of the non-technical issues that may have influenced behaviour.

3.2.2 Procedure

The Level 1 documents were input into NVivo and a thematic analysis was conducted to understand how non-technical issues may have impacted IMT decision-making. The coding themes were the non-technical issues identified in the literature review namely: decision-making, situation-awareness, leadership, communication, fatigue, teamwork, stress and emotion and

trust. Additional categories of assertiveness and personal limitations were added during the analysis to reflect the content of the reports.

3.3 Results

A perceived lack of decision-making process is a recurring theme throughout the thirteen Level 1 reports. However, the reports do not explicitly identify that non-technical issues could influence the decision-making process and only rarely imply their existence.

The coordinators of two Level 1 exercises, who edit the reports, added the folowing comments acknowledging that non-technical issues can impact IMT performance (2002, 2005). However, unfortunately the events that instigated these comments were not discussed.

> *'There appears to be an assumption (perhaps industry wide), that because a person holds a senior management position within an organisation, they must have the skills necessary to act in emergency incident management. This is not necessarily the case - and a number of the key skills were not always in evidence during the exercise.'* (2002)

> *'The discipline of emergency incident management is far more rigorous and requires more structure and discipline than normal management. The application is outside the normal routines and decision-making of managers. The technical skills required become all the more important when applied during an emergency - where time is always critical and stress, fatigue and personal responsibilities take their heavy toll. Such circumstances are clearly outside the day-to-day managerial environment in which people routinely operate. Their capacity to function may therefore be hampered and the expectations of their position within the organisation structure adds further pressure.'* (2002)

> *'From an industry perspective, there continues to be a slow response to gathering information that is available from the mandatory monitoring systems and eye witnesses. This may well be due to what is being understood as the debilitating effect of stress on a person in such cases. This needs to be addressed as a matter of importance in the same way as a structured approach is now being embraced. If people are not able to adequately manage the psychological impacts of such an incident, no amount of structure will succeed.'* (2005)

The information extracted from the Level reports that helps identify the role non-technical issues may play in the mining IMT decision-making process is discussed in the following sections.

3.3.1 Decision-making

Generally the recommendations propose structural and procedural improvements to the decision-making processes; following a process or procedure; applying a decision-making system; having a clear definition of 'how decisions will be made'; following disciplined systems; clarifying the decision-making processes; sticking to documented and formal processes; clarifying roles in decision-making; applying discipline; and improving the structure and focus on the decision-making processes. However, the decision-making process itself, despite being referred to frequently, is never clearly defined.

For example:

> *'Decision-making did not follow any formal process.'* (2003)

> *'Decision-making process needs to be streamlined.'* (2002)

> *'He informally attempted to follow proper decision-making process.'* (2006)

> *'There was no formal decision-making process evident within the planning group and the IMT.'* (2006)

> *'Improve the structure of the decision-making processes without unnecessary formality. Ensure that all personnel are aware of the ground rules for effective IMT operation prior to an incident being initiated.'* (2003)

> *'There must be established a central, clearly identifiable, decision-making process, based on risk assessment principles.'* (2008)

> *'There needs to be a clearly defined decision-making and validation process in place for all decisions, particularly those of the IMT.'*(2008)

The cognitive decision-making processes that are discussed in the decision-making literature, are not addressed in the Level 1 reports. This may be because they are invisible to observers or were not considered important. However, there is also a clear assumption that the ideal decision-making process is an analytical comparison-of-alternatives model such as the rational choice method.

For example:

> *'Each decision needs to be driven to completion. Techniques to capture ideas, generate alternatives and evaluate different options to allow for systematic comparison* (2001).

> *The decision-making process needs more focus and each option needs to be driven to completion before allowing digression.'* (2001)

'There must be established a central, clearly identifiable, decision-making process, based on risk assessment principles.' (2006)

These comments reflect an underlying industry assumption that the only good decision-making process is one that is objective and procedural, and that systematic analysis of multiple options will enable the decision-maker to identify the optimum solution. Equally it is assumed that poor decision-making is the result of not following through with such a logical and rational process.

Recommendations made to improve the decision-making process included the implementation of a management structure. However, since the implementation of MEMS, decision-making issues continue to be raised in the Level 1 reports. The recommendations now call for more rigour in adhering to the MEMS process including an additional role within the MEMS system; a process checker, indicating that the system is still seen as the solution:

'The QMRS should investigate whether or not MEMS should be modified to include a formal role for a process checker and also the streamlining of the forms used.' (2007)

These post-MEMS recommendations are an extension of the previous assumption; that process and structure are the key to good decision-making and that if only the MEMS system could be followed more rigorously, decision-making would automatically improve. The recommendations do not challenge the system, only the miners' inability to stick to it.

The calls for observable decision-making processes are likely to be based on an understanding that good decision-making should be process driven. However, it could also be the case that the assessors' desire for decision-making to follow an observable, pre-prescribed and well documented processes may be driven by the difficulty of observing and assessing decision-making when these systems are not in place. It is possible that when observers can't determine what the participants are thinking, from their behaviours alone, they are likely to recommend implementation of a process as evidence a process is occurring and ultimately, so they have something concrete to observe.

However, just because the decision-making process cannot be seen does not mean it is absent or that it is inherently less effective or valid than an observable method. It is also possible that this drive for observability stems from the understanding that if a fatality occurs, clear accountability will be required for both an incident inquiry, and any criminal investigation [82, 49, 50], rather than a belief that increasing documentation of decisions actually improves them.

For example:

'The lack of a formal recording system would be seen as a major discrepancy in a Warden's Inquiry in the process of determining true nature and cause as vital information can be lost.' (2006)

The following quotes highlight the extent to which the documentation of decision-making is promoted.

> *'Far too much informal planning occurred with little or no documentation.'* (2006)

> *'There must be effective recording procedures, especially by the Incident Control Team of any actions taken, decisions made or reasons/evidence supporting these decisions'* (2006)

> *'Verification of decisions, who made them, where they came from, and who should receive them may be improved.'* (2008)

> *'Ensure all instructions and decisions are formalised and recorded.'*(2008)

> *'the decision-making process was not recorded'* (2006)

It is therefore possible that because pre-defined processes and verbal discussions about decisions make them easy for assessors to observe, this has the potential to be equated to 'good' decision-making. The following evaluation of 'good' decision-making actually says nothing about the quality of the decision-making.

> *'It was good to see that, on several occasions, members of the IMT, other than the IC, forced the decision-making process to be rigorous and not take short cuts. On several occasions a course of action was decided upon, only to be overturned by a late question, which then caused a shift in focus and initiation of a risk management on a different scenario.'* (2001)

In the 2003 report the exercise coordinator made the following comment:

> *'decision-making in emergency situations is markedly different to normal decision-making processes. There is generally no time for proposing and assessing options and so on. There is a greater requirement for clear information, accurate appraisal of the situation, clear and positive actions based on a combination of facts and experience and all lead by the Incident Commander. This is not the time for courteous committee interaction and management protocols.'*

and he concluded the report by stating:

> *'Decision-making protocols were of a traditional nature and not appropriate for emergency situations. Naturalistic or Dynamic Decision-Making, as practiced by professional emergency organisations, offshore oil rigs management and defence forces should be utilised for mine emergencies'* (2003).

This indicates an understanding that emergency decision-making is different to conventional decision-making and that perhaps other methods would be beneficial. However, it seems that the concept of naturalistic and dynamic decision-making were not fully understood. The assertion contradicts what the IMT assessors actually observed in this exercise, because what they stated indicates that the IMT were actually using a naturalistic decision-making process:

> *'Typically an idea was proposed and agreement was sought. Generally this was not a documented process. The lack of documentation reduced the ability to objectively identify the issues and evaluate options.'*

In addition, the assessors continued to say that the decision-making process did not follow any formal processes, that it lacked integrity, that the informality of process contributed to decision-making delays and that the decision-making process was very brief and not exhaustive. In effect the assessors observed a decision-making process that was more akin to the naturalistic decision-making processes yet were calling for the typical structural, procedural and documented decision-making process. The misunderstanding is evident because of this contradiction within the Level 1 report but also because NDM and dynamic decision-making are not processes that can be taught, as is implied in the concluding comment. Both these methods are a description of what has been observed in previous research. It is possible that this confusion was a result of the coordinator attempting to find a better overall solution but not fully understanding the theoretical basis of NDM. Around the same time period, the focus of the recommendations was on replicating the emergency services processes, hence the development of MEMS.

> *'There is a further need to establish a clear organisational structure for the management of an emergency, including information gathering techniques, decision-making processes and communication mechanisms. These are available within professional emergency services organisations and should be reviewed and considered for adaptation to the mining environment.'*(2003)

In no other years, did the Level 1 report highlight that there is any other valid way of making decisions other than the rational choice method.

3.3.2 Situation Awareness

The reports described several instances where the IMT's situation awareness was incomplete or erroneous. Examples include: not determining the source of a fire; working on false information regarding the location of a body; not recognising that there were ignition sources at a particular location underground; and an IC being unaware that help had arrived from other mines and the emergency services.

Most of the comments coded to situation awareness were related to communication and were coded to a sub-theme of 'data gathering'. Data gathering is the lowest level of situation awareness as defined by Endsley (1988) and the frequency with which related comments appeared in the Level 1 reports suggests that this is either the most troublesome stage of situation-awareness to acquire or potentially that it is the easiest to observe.

For example:

> *'Greater emphasis and diligence must be placed on gathering information and understanding, as far as possible, of what is actually happening, who is affected and what equipment is required. This will come from witnesses, rescue teams, gas monitoring and other mine monitoring. This will then flow onto the quality of decisions made and actions taken.'* (2003)

> *'The break down in accurate communications resulted in decisions that may have had catastrophic consequences e.g. the tube bundle monitoring system was always operative and was providing vital data that was not utilised for over three hours. A vehicle was dispatched underground on the belief that there was only 50ppm CO present. This was simply the off-scale reporting figure of the sensor software. There was in fact over 6% CH4 and 600ppm CO in the 703 TG when that vehicle went underground. Interpretive analysis of the available data would have provided the Incident Control Team with early warning of the development of a major fire, its rapid propagation AND if left untended, there was a real probability of a second explosion'.* (1998)

Given that verbal communication is the primary source of information for the IMT, and that it is this information that the IC and IMT will use to build their situation-awareness, it is difficult to arbitrarily create a distinction between recommendations and text targeting situation awareness and those targeting improvements in communication or information management. The term situation-awareness was used infrequently, but this absence is not indicative that situation-awareness is not problematic, it is more likely because the distinction between gathering information and situation-awareness is unlikely to be made by Level 1 assessors. It is implicit in the reports that if the correct data reaches the right people then situation-awareness is achieved. This is not necessarily true given the complex nature of deriving situation-awareness.

The recommendations made have consequently focussed on the improvement of, or implementation of, more processes to ensure data is not lost. Acquiring situation awareness, has been portrayed in the Level 1 reports as a factual and objective process of gathering data that is vulnerable to procedural failure, incorrect technical data or the unreliability of having human beings conveying the messages. The recommendations related to improving the amount of information getting to the IMT, have generally involved computerising information management systems.

For example:

'The communications interaction between the various operation areas needs to be systematically organised such that all operational areas are provided with the necessary information and updated regularly. Consideration should be given to undertaking this electronically to minimise the disruption of phone calls.' (2002)

'Consideration should be given to the processing of incident information and decision-making online so that all parties, including SSE and QMRS have all information readily available.' (2006)

'Develop improved incident management aids for the Incident Management Team to assist the application of a disciplined system for information management, recording and decision- making.' (2006)

The recurring proposal to use electronic data to minimise communication errors highlights a disregard for any advantages the people within the systems could bring to the process of acquiring situation-awareness such as sensing when information is being withheld, reading body language, or simply obtaining more information through conversation and discussion.

The focus of these recommendations is on making sure every piece of information is available and documented for view by anyone who could want it. This is essential to the extent that technical data is used as the basis of technical decisions, therefore the data needs to be accurate and complete. However, these systems only address part of the problem. Sometimes the technical data alone, or that which is available, cannot reveal the situation by technical interrogation alone. Data is often incomplete, ambiguous or potentially erroneous in the emergency environment, and in many cases waiting until the data is complete would render any decision useless.

The Level 1 recommendations do not address the social or the cognitive aspects that can impact the formation of situation awareness when the data is not ideal. Further, technical or electronic systems do not eliminate the cognitive issues that can impact situation-awareness. For example jumping to the conclusion that the phones were off-line simply because they were not answered (2002). Groupthink is an example of a social issue that was observed in 1999. Issues such as these are not the result of missing or falsely conveyed information and are just as likely to occur whether or not there is a system in place.

In addition to maintaining situation-awareness of the incident the IC must maintain awareness of the emergency management operation itself. It is recognised in the reports that, in this case, interpersonal communication is valuable:

Incident controller did not move between teams, this resulted in information being lost and IMT making decisions on limited information. Suggest that between formal IMT meetings the Incident Controller moves between teams both to gather information and keep the teams abreast of the current details he has to hand. This would also be an ideal opportunity to boost morale and keep spirits up that can flag over long periods.(2008)

The Incident Management Team must not become isolated from events. There must be an area of refuge for decision-making and discussion, but the IMT itself must circulate in order to gather information and assess how events and actions are progressing.(2003)

Debriefing

A data source that has been consistently under-utilised in Level 1 exercises is collecting information from the crew members who exit the mine immediately before or after an incident. The purpose of this debriefing process is to gather first-hand data from those who may have seen, smelt or heard something underground that could assist the IMT to understand the situation underground.

For example:

'Information from debriefing sessions to be incorporated into the decision-making process. For example, the operator of the vehicle may have provided useful information to assist that decision-making process (eg., the fire was relatively small, the fire was actually 20m inbye 9 cut-through). Critical witnesses should be identified and also de-briefed by IMT so that they can get a better understanding of underground conditions.' (2002)

The debriefing problems identified in the Level 1 reports include: people being debriefed as a group; those who conducted the debrief asking poor questions; the information obtained from the debrief not reaching the IMT; or simply that debriefing was not conducted. Recommendations arising from these observations include:

'A protocol for this type of communication should be developed with sample questions. All questions asked should be read from a written copy so that the answer options can be reviewed against the exact question.'(2006)

'Review the process for the debrief of mineworkers to ensure that relevant information reaches IMT ie the ERZ controller from the longwall was debriefed several times and the key information about a broken down vehicle in the maingate was not identified' (2007)

'Dedicated personnel need to be assigned to the debriefing of underground eye-witnesses and collation and communication of this information to the IMT.' (2004)

These recommendations are clearly advocating more process and structure as the solution to the debriefing issues. Yet improvements have not yet been observed. Debriefing failures have been observed as recently as 2012.

Validation

Accurate data is pre-requisite for accurate situation-awareness. Validating data has often been overlooked in Level 1 exercises and as a result the following procedural recommendations have been made:

> *'ensure that we are dealing with accurate information and that all groups are dealing with the latest and validated information.'*(2006)

> *'There needs to be a clearly defined decision-making and validation process in place for all decisions - particularly those of the Incident Management Team.'*(1999)

3.3.3 Leadership

Two leadership issues discussed in the Level 1 exercises include having a 'dominant IC' steering the IMT towards making the decisions that he wanted (1999), and an IC's reluctance to ask for assistance or advice from others (2002, 2006). Both behaviours have led to poor decision-making, either directly or by impacting the information flow and the IMT's subsequent situation-awareness.

The IC's reluctance to ask for assistance or advice from others

The Level 1 reports highlighted that the IC is often reluctant to request help. Since 1998, the reports have frequently recommended that IMTs engage experts such as the QMRS, the police, skilled personnel from neighbouring mines and recognised gas experts. In one case the mine's own ventilation officer's expertise failed to be fully utilised.

> *'The SSE was reluctant to involve the police at the start of the exercise and request them to come to site. He maintains that police are only required for fatalities. District Inspector insisted that police be called to site at 1.03pm'.*(2006)

> *'The application of the Ventilation Officers expertise into the decision process was not utilised. The failure to recognise this vital aspect did not allow full exploration of a range of possible mitigating options.'* (2002)

The dominant IC

Assessors noted that an Incident Controller in the 1999 exercise was not collaborating with the IMT and essentially making the decisions himself:

> *'The Incident Controller was dominant in the IMT. Team member opinions were listened to by the Incident Controller but not always considered in any subsequent decision.'* (1999)

'The Incident Controller led the decision-making process and only appeared to use the IMT as a form of validation of his decisions.' (1999)

There were also occasions when the IC's behaviour was believed to have negatively impacted the IMT's situation-awareness:

'Little evidence was observed to suggest that any other scenarios were considered outside the Incident Controller's original scenario' (1999)

'The Incident Controller had already developed a scenario that identified the existence of a fire prior to the formation of the IMT. The IMT subsequently confirmed the Incident Controller's hypothesis. Only limited validation techniques were used by the IMT' (1999)

'The prioritising of information type and flow was almost solely determined by the requirements of the Incident Controller. This resulted in the Incident Management Team maintaining a somewhat narrow focus' (1999)

It is unlikely that this was the only year such circumstances arose, especially as similar observations were made by the author in a recent Level 1 exercise. It seems likely the limited number of examples of leadership issues in the Level 1 reports is a consequence of moving away from actively critiquing performance, especially as the identity of the IC would be apparent to those in the industry.

3.3.4 Assertiveness

Assessors noted that the problem of a dominant IC was exacerbated by members of the IMT, not challenging the IC. Why they didn't challenge is speculation, but could be indicative of a lack of assertiveness from team members. Equally, it could be because the IC did not maintain an environment conducive to open communication, because the IMT members lacked technical knowledge or any number of reasons driving the IMT to simply go along with the leader's beliefs.

'Incident Management Team was disinclined to challenge assertions and strategies adopted by the Incident Controller.'(1999)

'Incident Management Team members remained totally supportive of the Incident Controller throughout the entire conduct of the exercise. This may have resulted in some opportunities being missed to explore alternative strategies.'(1999)

3.3.5 Communication

The IC almost solely relies on communication from IMT members to derive his/her situation-awareness. The criticality of good communications has been recognised in the Level 1 reports:

> *'Accurate information flows must be established to minimise decisions that may result in catastrophic consequences.'* (2009)

Communication recommendations have generally emphasised physical solutions. When communications were deemed to fail due to human error, implementing further systems was recommended. For example:

> *'Electronic white boards (for recording), accurate mine plans, desktop space, communication facilities-preferably with automatic call-forwarding of all incoming UNDERGROUND phone calls, video/audio recorders, secretarial /shorthand support and security against intrusion are not just desirable - they are absolutely vital.'* (1998)

> *'A systematic regime should be established for reporting and displaying monitoring information. Without systematic recording of information it is impossible to effectively brief external bodies or undertake changeover of key personnel.'* (2006)

> *'Communications between the Incident Management Team and 'eye witness' personnel from underground needs to be accurate. Consideration should be given to defining the communication flow in an emergency to prevent the 'informal' channels developing during an incident.'* (2003)

> *'All instructions from the Incident Management Team should be in a written format - verbal instructions are often misinterpreted.'* (2003)

3.3.6 Fatigue

The Level 1 reports indicate that fatigue can negatively impact decision-making by slowing cognitive processes. However, this is an assumption based solely on observation. Slowed processes could have resulted from other non-observable non-technical issues such as frustration, hunger or stress. For example:

> *'As the exercise proceeded through the night, the onset of team fatigue became apparent.'* (2000)

> *'The fatigue of the IMT became evident in the early hours of the morning and the ability to make decisions and carry out analysis was demonstrably slowed.'* (2001)

Fatigue issues receive a lot of attention in the mining industry, therefore it is possibly the most commonly accepted non-technical issue. However, even so, it seems that a stigma remains attached to fatigue. The statement below is almost apologetic for highlighting fatigue as a potential issue:

> *'Ensure the number and balance of the IMT is correct. This is by no means a criticism of the Newlands team who performed admirably. It is more a question of fatigue and how long a team should remain constituted until relieved.'* (2000) (Emphasis added)

The solution proposed for fatigue was a systems approach:

> *'A systematic process for evaluating fatigue should be implemented rather than rely on the individuals to notify the Incident Controller of their status.'*(2006)

The means by which this could be operationalised was not detailed but designing a process to evaluate fatigue in other people, outside of a laboratory context, to a reasonable degree of accuracy is complex and unrealistic.

A standard (one-size-fits-all) fatigue management plan that sends people home after a certain number of hours may not be ideal. The following statement acknowledges this but does not consider that social and emotional factors would make it impossible to persuade half the workers to go home if an incident involving people had occured:

> *'It is difficult to make prescriptive rules for fatigue management that apply equally to any emergency. However, the effects of fatigue on the quality of decision-making cannot be ignored. Fatigue management for an ICT should include:*
>
> - *arranging for half of the ICT to go home to bed as soon as it is known that the problem will take longer than a full shift to solve*
> - *identifying a back-up person for each key person on the ICT*
> - *members of the ICT admitting that they are tired and arranging a replacement.'* (2010)

3.3.7 Teamwork

Teamwork has broken down during Level 1 exercises both within and between the functional teams, and at shift changeover. There are also several examples of confusion occurring between the roles and responsibilities of the operations, planning and logistics teams. For example:

> *'From the concentration of functions in Operations it would appear that in many ways they were a de facto IMT.'*(2008)

> *'Operations personnel carrying out what would normally be classified as logistics functions.'* (2008).

'The new IMT personnel need not only to gain the information from the previous team, they also need to maintain the momentum of the IMT and the group dynamic. This is often best achieved through a staggered change-over. This staggered change-over can commence as early as the 5 hour mark with the IC usually the last to change out. The IC cross over may take up to 2 hours as the IC is often very difficult to move on.' (2001)

'Three senior people made a number of decisions in isolation from the rest of IMT.' (2000)

'Underground Mine Manager started to define his own goals.' (2003)

Recommendations regarding better understanding of roles and responsibilities have generally been proposed as the solution to teamwork issues, as has training on the use of the MEMS incident control system.

'ICS - The personnel need to be trained in the functions required for the ICS system to work. This training relates not only to the functions of an individual but also recognition of the roles and responsibilities of others and the appropriate interaction mechanisms.' (2006)

'The role of the QMRS within the IMT should be clearly defined e.g. formally recognised as part of the decision-making team and/or advisory and/or implementation.' (2006)

Interestingly, the favoured decision-making process appears to be reliant on collaboration with the team, yet it has been stated that it is most effective when only the core IMT members participate (2003).

'All IMT members need to be encouraged to actively participate in the decision-making process.' (2006)

'It appeared that decision-making was most effective when the IMT consisted of only the core members.' (2003)

The implementation of clear goals is another strategy employed to facilitate teamwork:

'Additionally, the exercise highlighted the critical need for Incident Management Teams, Duty Systems and aided rescue agencies such as the Mines Rescue Services to set clear, complementary and unambiguous goals and objectives, establish priorities and tracking mechanisms for attaining such goals and to maintain a strict discipline of process management throughout.'(2002)

3.3.8 Stress

In terms of psychological stress within the IMT, no recommendations were made and there were only a few references to stress within the reports. In one report stress was mentioned as the possible cause of slow data gathering, and in another stress was reportedly caused by miscommunication.

A number of possible conclusions could be drawn from the limited acknowledgement of stress:

- The level 1 exercises themselves were not stressful to the IMT members.
- The reports did not mention stress out of concern it would be taken as a criticism.
- The effects of stress may not have been recognised by the assessors.

3.3.9 Emotion

There were very few references to emotional issues in the Level 1 reports. One of the few acknowledgements that emotion directly impacted the IMT's decision-making performance was:

> *'Once the report was received that the fire was out the sense of achievement was extremely evident and a detailed focus on the rescue of the missing contractors began immediately. This relief and sense of purpose quickly dissipated on the receipt of the report that the fire had re-ignited.' 'From this point energy levels, focus and the rationale behind the decision process faltered to a degree and at times erroneous information communicated to the IMT with respect to the coordination of the rescue teams did little to assist.'* (2000)

It is possible that because participants know that the exercise is not real, it is not conducive to creating an emotional response. Evidence of this includes several comments such as:

> *'The whole situation in the incident management room was surreal. There were people in danger below ground and there was no sense of urgency and no firm and hard decisions being made.'* (1999)

> *'There needs to be more urgency in decision-making when retrieving persons underground who are injured or have limited life support equipment available.'* (2006).

However, emotion is a broad category that includes many feelings. Frustration was mentioned in the first Level 1 report: an assessor commented on the fact that communication with the mines rescue service should be both forthcoming and sought from the IMT and that the lack of *'information can, and did, lead to increased tensions and frustration and should be corrected'* (1998).

Level 1 exercises have not embraced the opportunity to have the IMT engage with people who are undergoing emotional trauma. The IMTs have never been put under stress from

those who have withdrawn from the mine and who have potentially seen mates injured or killed and then undertaken a long, hot, arduous walk out of the pit. Only in the 2003 report an assessor acknowledged the complexities of considering the emotional state of others whilst working through the decision-making process and at the 2011 exercise, the exercise immediately following the Pike River disaster, an actor, playing the mother of a miner who was unaccounted for, arrived at the mine site. However, the only reference to this in the report was:

> *'... the person fulfilling the role of surface security, for example, should be trained to deal appropriately with a distressed family member, or be supervised in doing so'* (2011).

3.3.10 Trust

Trust was only identified in one Level 1 report:

> *'Trust needs to be developed and accepted in certain areas, i.e.:*
>
> - *QMRS to trust the mine personnel in their solving of mining issues.*
> - *Mining personnel to allow QMRS to develop intervention plans.*
> - *Mines rescue brigadesmen to trust the validity of direction from QMRS staff.'* (2007)

3.4 Discussion

The Level 1 reports have provided the industry with many recommendations over the years with the intention of improving emergency management performance. Decision-making recommendations are clearly motivated by the view that optimal decision-making is the result of an analytical process whereby information is sought, options are systematically compared and an optimum decision is made. It is assumed that an optimal decision will result from sticking to a process. The recommendations have called for mines to pre-define a clear emergency management decision-making process detailing how decisions will be made, and then adherence to these formal processes by applying discipline and maintaining the formality in the systems.

The recommendations indicate the industry is supportive of a collaborative decision-making process by the calls to include all IMT members in the decision-making process. This is reliant on many non-technical issues including the team's communication skills and their willingness to challenge the incident controller. However, the MEMS focus is solely on tasks; know your own role, know your colleague's role and stick to them. This is task-work, not team-work, where people work collaboratively together [172]. Indeed, the prevailing attitude seems to be that the human beings in the process can only harm it and their inherent non-technical skills are not valued.

The reports raise a concern that perhaps those being assessed in the Level 1 exercises may be acting in a way that they believe will earn them *'Favourable judgement of performance by peers.'* One assessor commented that there appeared to be a *'competition mentality'* in the exercise which may impact on the behaviours observed, and in 2007 the report stated *'In some cases the Level 1 Mine Emergency Exercise is being regarded as a pass or fail test by mines whereas, in fact, it is a test of the statewide response with an opportunity for an individual mine to test, trial and learn about its own emergency response plan.'* (p5, 2007). It seems that over the years, the true purpose of the Level 1 exercises, one of the legacies of the Moura disaster, may be becoming forgotten.

The desire not to be overly critical in the Level 1 reports has driven assessors to list issues with a positive bias. Many statements indicate that non-technical issues may have arisen, but no detail is provided that could help others to learn. For example, in a section titled "Positive points noted by assessors" the following statement is included: *"The absence of friction between IMT members"* (2001). Does this indicate that this normally occurs in this assessor's own experience? Similarly, in 2003 *"First signs of relaxation, maybe because of steady state situation and first time that most information has arrived"* (2003). Does this mean they were stressed beforehand and it was a problem? And also in 2003, *'There was never overt conflict within the IMT, however, divided views did emerge that could have been reconciled'* (2003). Again, what happened and could the industry have learned from it?

The early Level 1 reports, from 1998 to 2003, included names of miners and the names of the assessors, there was text about what assessors believed or felt, behaviours were critiqued, subjective statements were made and overall the reports were more informative. These early reports seem to be more in-line with the spirit of the Moura recommendations as they promoted learning by discussing the issues that had gone wrong in context. Whereas, the recent Level 1 reports are sanitised and essentially only make generic recommendations. These recommendations only address the need for improvement but do not add anything to the readers' learning about what could go wrong and the specifics of preventing it.

Further evidence of a shift in priorities for the Level 1 reports is contained within the following debriefing recommendation with a direct reference to incident investigations:

> *'Develop improved debriefing techniques. This has application in incident investigations as well operational activities.'* (2012)

As a side issue, this confuses the purpose of the debrief and is only likely to make it a less useful tool for gathering open and honest information during an incident if the association with investigations is maintained leading to connotations of potentially incriminating oneself .

Further, from the researcher's own experience within three recent Level 1 organising committees, non-technical issues have been deliberately omitted, or significantly sanitised before inclusion in the Level 1 reports. Behaviours observed such as becoming stressed or emotional have been omitted from the reports potentially to avoid insulting or embarrassing the individ-

ual or showing-up the mine itself. This seems driven by an attitude that if anyone behaves in anything other than a rational manner, it would be offensive to point it out. For example, as stated earlier, one IC was seriously blinded by confirmation bias. The reference in the Level 1 report was as follows:

> *'At times the ICT appeared to be looking for information to confirm a view that they already held, rather than objectively analysing the data'.*

This statement does nothing to promote understanding or learning about decision biases such as the fact that confirmation bias is extremely common, and does not only happen to 'other' people. Prior to the exercise this IC was highly aware of the psychological and social issues that can influence decision-making, yet when immersed in the situation he did not realise he was being controlled by a bias (personal communication). We all succumb to biases. To judge is simply arrogance, and to omit details because of perceived judgement is to deny the industry of good learning situations.

The absence of non-technical issues in the Level 1 reports reveals an under appreciation of these issues by the industry, either deliberately or unintentionally. Thus, this opens up the possibility that decision-making could be improved by addressing them. In the next chapter, direct observations of the IMTs in the past three the Level 1s are discussed alongside observations of emergency simulations staged at MEMS training courses. This first-hand observation is intended to improve understanding of how non-technical issues can impact IMT decision-making.

4 Mining Emergency Management Simulations

4.1 Introduction

The aim of this thesis is to explore the role of non-technical issues in IMT decision-making at underground coal mines. A review of the literature in Chapter 2 described the non-technical issues that have been identified as critical to optimal performance in other industries alongside others that may be relevant to mining. These include decision-making, communications, situation awareness, teamwork, leadership, emotion and trust. In Chapter 3, an analysis of Level 1 emergency exercise reports revealed that these non-technical issues may also influence a mining IMT's decision-making during these exercises. However, due to under-reporting of non-technical issues in the Level 1 reports the impact on decision-making remains unclear and under-acknowledged. Building on this, the current chapter discusses direct observations of IMTs participating in emergency exercises to further explore the role of non-technical issues play in IMT decision-making.

Pilot observations conducted for this research revealed the difficulty of making meaningful observations of non-technical issues. Decision-making and situation-awareness, due to their cognitive nature, were particularly difficult to observe. Consequently, a mining specific observation template, a measure of situation-awareness, and a post-simulation semi-structured interview script were developed to assist with, and augment, the data collection.

The observation template helped structure the observations collected. Using a template can be a limitation because of the tendency for an observer to only report issues that fit within the template [73]. However, the four categories in the template were broad and the researcher was aware of this tendency and actively sought to identify all non-technical issues, not only those included in the template. Using a template is an accepted observation method within non-technical skills research [73].

The situation awareness measure was loosely based on the Situation Awareness Global Assessment Technique (SAGAT) method [59]. This technique was developed to assess pilots' situation awareness during electronic flight simulations and involves the simulation being frozen in time to allow a researcher to verbally probe the participant about their situation awareness [61]. Generally, three probe questions are used that correspond with the three levels of situation awareness defined by Endsley: perception, comprehension and projection [59]. The questions are normally developed following intensive research of the task to ensure they are appropriate for the different stages of the simulation [61, 146]. Due to the exploratory nature of the current research, and that the observations were to be conducted during a real-life training exercise, a highly simplified paper and pen method was used to probe the IMT members at various times

during the mine-emergency exercise.

When possible, semi-structured interviews were conducted with IMT members after the exercises to explore the role the participants believed non-technical issues played in the team's performance. The interviews also provided an opportunity to clarify the thinking behind some of the behaviours observed.

4.2 Method

4.2.1 Participants

The participants were employees of the Queensland mining industry and were either attendees of two MEMS training courses run by the Queensland Mines Rescue Service, or were employees of the mines hosting the last three Level 1 exercises. All participants were typical of those who may be required to take IMT roles in a real event. However, collectively, the groups attending the MEMS training did not necessarily have all of the technical skills that would be available at a mine-site because people from different mines attended the same course. For example, in both MEMS simulations, the IC was not played by a current mine-manager or SSE because there was no mine-manager attending these particular MEMS courses. In all five simulations, all IMT members were male except for the scribes.

The study procedures were approved by the Human Ethics Committee at The University of Queensland. Fully informed, written consent was obtained from all MEMS participants but no consent was sought from those observed at the Level 1 exercises because observational assessment forms part of the mandatory process.

4.2.2 Materials

The materials developed to facilitate the simulation observations are described below.

Mining specific observation template

Anaesthetist, surgeon and pilot behavioural marking scales formed the basis of the mining specific observation template. These existing scales were designed, and have been validated, to enable observers to rate non-technical skills in these professions [180, 224, 225].

These behavioural rating scales use a three level framework where the non-technical skill categories are subdivided into elements and then into relevant behaviours. At the highest order level (the categories), these high-reliability industries have common core non-technical categories including teamwork, leadership, decision-making and situation-awareness [73]. These categories are divided into three to five elements which are more industry specific than the categories. At the lowest level of the scale examples of good and bad behaviours help raters evaluate performance within a particular element.

The mining specific observation template adopted the common categories identified above: teamwork, leadership, decision-making and situation-awareness. Lower order elements from the existing templates were adopted if they appeared relevant to the mining IMT or were easily adaptable [66, 72, 83]. However, at the behavioural level, most examples from the existing scales were irrelevant due to their industry specificity. The full behavioural mining specific observation template is included below in Table 4.1.

Situation awareness measure

The following three questions were designed to assess the participants' three levels of situation-awareness at particular times during the simulations:

- What are the key facts?
- Describe the current situation.
- What do you think could happen next?

Post-simulation semi-structured interviews

Two sets of questions were developed, one for the IC and one for the remaining IMT members.

Interview questions for IC:

1. What do you think you did well in terms of people and leadership skills?
2. If you did this scenario again what would you do differently?
3. What people/social/psychological skills in IMT members would have made your job easier?
4. If you were in a similar scenario again what would you hope others would do differently?
5. In general, what people skills do you think are important in situations such as this?

Interview questions for other IMT members:

1. What do you think the IC did well in terms of non-technical skills?
2. If you did this scenario again what should the IC do differently?
3. What people skills in IMT members would have made your job easier?
4. What people skills do you have that you think helped you the most?
5. If you did this scenario again what would you do differently?
6. If you were in a similar scenario again what would you hope others would do differently?
7. In general, what non-technical skills do you think are important in situations such as this?

Table 4.1: Mining specific observations template

Category	Element
Teamwork	*Team coordination (including team building and conflict solving)* Considers roles and responsibilities, requirements of teams, establishes open communication, gets feedback, allocates tasks and deals with conflict. *Sharing information* Provides updates, clear documentation, communicates plans, listens to concerns, encourages input and ensures shared understanding. *Collaboration (considering and supporting others)* Considers the condition of other team members, asks for assistance, monitors others, acknowledges concerns of others and anticipates the needs of others.
Leadership	*Authority and assertiveness.* Makes requirements known, leads, provides clear orders, motivates team and speaks up when necessary. *Setting and maintaining standards* Leads by example. *Coping with pressure* Remains calm under pressure, takes responsibility, doesn't freeze, takes responsibility and does not attribute blame. *Prioritising, planning and preparation - workload management.* Discusses priority issues, orders tasks and distributes tasks accordingly.
Decision Making	*Problem definition* Gathers sufficient data to identify problem and discusses with relevant people *Identifying and considering options* Considers options *Selecting options and communicating them* Considers risks of options, reaches decision and clearly communicates it, makes plan 'B'. *Implementing and reviewing decisions* Re-assesses situation and changes to plan 'B' if necessary.
Situation Awareness	*Gathering information* *Recognising and understanding information* *Projecting and anticipating future states*

4.2.3 Procedure

Familiarisation

Pilot observations were conducted to familiarise the researcher with MEMS and the mining industry in the first year of this thesis. The researcher attended three MEMS training courses; once as a participant and twice as an observer, and attended two emergency simulations staged at mines. The researcher also physically went underground at two mines.

MEMS Observations

The MEMS course is held at a conference venue and is a five-day residential course. On the penultimate day of training a day-long simulated emergency is staged that involves the formation of an IMT and the functional groups that support it. In an attempt to replicate reality a gas-monitoring simulation for the fictional mine must be interpreted by the team as one aspect of maintaining situation-awareness of the conditions in the underground mine. The IMT and the group members must communicate via telephone with actors who take on the roles of underground workers, suppliers, company head office, concerned wives, neighbouring mines, and the media. Further details of the scenario are confidential. The researcher attended the three days of training prior to each simulation to minimise experimenter bias.

During the MEMS observations, the observation template, the situation awareness measure and the semi-structured interviews were used. Prior to the simulations, the researcher set up a desk where the IMT meetings could be heard and observed without being disturbed. During each IMT meeting the researcher completed an observation template and upon completion of the simulation, combined the key points into a single template. The course coordinator completed a template at the end of each simulation to verify the researcher had not missed a critical decision-point.

The situation awareness measure was provided to all IMT members at the same time. The purpose was to determine if the IMT members all had similar circumstantial situation-awareness at the same time. Further, a comparison of the IMT members' situation-awareness with the real situation could be made because the person operating the gas simulation informed the researcher if significant changes to the gas simulation were made.

Semi-structured interviews were conducted immediately following the simulations with the all five members of each IMT (the incident controller; the scribe; and the leaders of the operations, planning and logistics groups). The interviews were conducted where the interviewees could not be heard by the other participants.

Level 1 Observations

Permission was granted by the Level 1 organising committees for the researcher to attend three Level 1 exercises as both a researcher and as an assessor. The researcher took comprehensive

chronological notes to assist with the development of the Level 1 reports. Consequently, the observation template was completed between IMT meetings and finalised post-event using the comprehensive notes. Video and audio recordings were referenced if required for clarification. The observations template was only completed at the most recent two Level 1 exercises. Circumstances allowed one structured interview, and one informal interview to be conducted with the ICs following two of the Level 1 exercises.

4.2.4 Analysis

The completed observation templates and the transcribed interview scripts were input into NVivo and a thematic analysis was conducted. The coding themes were the non-technical issues identified in the literature review namely: decision-making, situation-awareness, leadership, communication, fatigue, teamwork, stress and emotion and trust. Additional categories of caring for others and personal strengths and limitations were added during the analysis. The completed situation awareness questionnaires were examined for consistency between IMT members and with the actual situation.

4.3 Results

The MEMS and Level 1 observations, the situation-awareness measures and the post-simulation interviews are considered together in the following results sections. Each section relates to a non-technical issue that emerged from the analysis.

4.3.1 Decision-making

As can be seen in Table 4.1, the decision-making category in the observation template comprises of three elements taken from existing behavioural marker systems that indicate a three stage analytical decision-making process may be observed. They include identifying options, selecting an option, and reviewing outcomes. However, the observations revealed that this was the dominant decision-making process because options were rarely considered.

With hindsight, to help identify decision-making processes, the researcher was initially looking for overt discussion surrounding decisions and significant decision-points such as those that would impact upon the safety of the miners underground or potential rescuers. However, this pre-conception of what an emergency-management decision might look like also proved unfounded. Most of the IMT's time was spent trying to achieve and maintain situation-awareness. However, the process of acquiring situation-awareness actually involved many sub-decisions such as who should collect data, what type of data should be collected, and how this would help identify the problem. These types of decisions rarely fitted the description of the rational choice decision-making process prescribed and assumed by the industry and conventional decision-making literature.

Several decision-making processes were observed. The use of procedures was one. Examples included the determination that evacuating the mine was not yet necessary because the gas level trigger point had not been reached, and another was that regulations precipitated an ICs decision to call the mines rescue service upon the discovery of people unaccounted for after an incident. In all but one of the five exercises, the ICs adhered to their duty-cards or other pre-prepared role checklists which gave them tasks to do. This checklist type strategy is employed in many industries to guide the decision-making but these can introduce other issues. For example, one IC completed his tasks in the order they appeared on the duty card, rather than prioritising the tasks in order of importance. It was observed that the IC organised the next shift to take over the response in nine hours' time (part of the fatigue management plan) before establishing the extent of the situation. Not having a strategy in place to deal with fatigue issues has been heavily criticised in Level 1 reports, therefore it seems likely that this may have driven the priority status of this task on the pre-prepared duty-cards.

Creative thinking was precipitated by the receipt of new information that there was an individual missing in the underground mine. The situation was that there was a smouldering mine vehicle (it had been on fire) in the main access route into the mine and it was maintaining a condition of irrespirable air in the mine meaning that industry protocols dictate the mines rescue service is required to conduct the search and rescue. However, the fresh air side of the vehicle (between it and the mine exit) was safe and the IC was unhappy with the time it would take to deploy mines rescue teams to look for the missing miner, so he decided to have the smouldering vehicle pulled out of the mine to allow the mine-ventilation to clear the air in the mine naturally enabling non-rescue personnel, who would be quicker to deploy, to undertake the search. Some IMT members were initially opposed to the idea as they had been told by the police-officer that the vehicle should not be moved to preserve evidence for their investigation (a man had died in the vehicle). The IC discussed his idea with the IMT coordinator, mentioned it to others and at the next IMT assertively presented his solution to the IMT and the police-officer. The police-officer agreed that improving the air quality in the mine, to potentially sustain life, took priority over preserving evidence.

Due to the overt nature of this decision it was one of the easiest to observe. The IC received information (that someone was missing underground), he considered his options - this was done in series not parallel (i.e. the delay was unacceptable so he looked for a new option rather than weighing-up both options simultaneously), he made the decision, he discussed it with others but did not concur with their concerns about evidence tampering so he presented it to the IMT and the police-officer for approval. This one decision involves many of the decision-making strategies outlined in the literature. It is one of the most analytical decisions observed, yet was still more representative of naturalistic decision-making processes, where the situation awareness is obtained and a suitable action identified. Several options were not compared and contrasted in pursuit of an optimal choice.

4.3.2 Communication

A mining IMT is reliant on good verbal communication to derive their situation-awareness and discuss decisions. Verbal communications skills are vital for IMT members and those delivering information to them. However, verbal communication was seen to fail on many occasions resulting in reduced efficiency of the IMT and the emergency management operation as a whole. Communication broke-down for a number of reasons including that people deliberately chose not to speak; through errors in the transmission and receipt of information, including information not being heard or processed properly; and communication being misinterpreted or misunderstood.

Deliberately choosing not to speak

Of the ways communications failed, people choosing not to speak was most frequently observed, and was the most disruptive to the IMT's performance. It meant that some information was not shared, concerns were not raised if there was disagreement and clarification was not sought if a task was not understood. Examples of observations where people withdrew from communication include:

- A team member's body language made it obvious that he disagreed with the team leader but he did not communicate this and only the leader's point of view was considered in the discussion. When interviewed afterwards he said he saw no point in speaking up because of the personality of the team leader.

- A team-member in one of the IMTs stopped contributing to the IMT meetings. In the post-simulation interview he did not state explicitly why he stopped speaking but commented on the IC's abruptness and how the IC didn't pick up when team members did not understand what was happening. Another IMT member believed that almost all the IMT members deliberately stopped speaking-up in the meetings and only responded to direct questions from the IC because they disliked his demeanour.

- There was a seven minute delay between the IC asking a team member to ask the mock 'control room officer' (the person operating the gas simulation) for clarification of the scale on a graph and him doing it. The team-member did not do anything else in the seven minute delay and when he eventually asked for clarification it was prefaced with a summary of his experience to explain why he did not understand the scale. He seemed extremely reluctant ask for help and delayed the process.

- It was apparent that a team-member had information he wanted to tell the IC on a number of occasions, yet he didn't verbalise this. Instead his behaviour became belligerent over time and he displayed a lack of interest in what the IC was trying to explain to him by fidgeting and looking away from what the IC was pointing to.

From the five simulations observed, the quality of the IMT communication seemed highly dependent on the IMT environment the IC created, and how the team members reacted to it. In two out of the five simulations the IC behaved in an arrogant and hostile manner and this directly impacted the amount of information the team was willing or able to share with him. In the three other exercises, the ICs were open to collaboration and these ICs were generally kept better informed by their teams. However, one of these ICs was reliant on the team for technical expertise meaning that perhaps his collaborative techniques were borne out of necessity rather than preferred style.

Some examples of the behaviours observed that appeared to contribute to developing an IMT environment conducive to effective and efficient communication include:

- Establishing early that asking for clarification or for significant information to be repeated is acceptable. In the initial IMT meeting the site senior executive asked the mine-manager, who was the IC, to repeat details. The exchange was amicable and seemed to set the precedent for future meetings.
- The IC used team-members' names to ensure that the person, who the information was relevant to, was actively listening.
- Visually focussing on a mine plan, rather than the other person, aided discussion and also seemed to diffuse building conflict on several occasions.
- When IMT meetings followed the same process throughout the simulation, whereby each IMT member was given an opportunity to speak, the IMT members did not interrupt others which encouraged listening.
- The IC asked each team member, by name, at the end of the meeting if they had anything else to share. However, even with this strategy some team-members did not share their knowledge.
- At the end of each meeting the IC summarised the tasks each IMT member was expected to complete before the next IMT meeting. He used the team members' names to check they all knew who was responsible for each action and waited on their recognition before moving on.
- The IC encouraged input from the IMT throughout the meeting discussions, 'can anyone else see anything?', 'anything else we need to do?'

Some behaviour observed that hindered effective and efficient communication in the IMT include:

- Mobile phones being answered in the IMT. In one case the constant ringing of phones in the IMT caused an IC to lose his temper and he requested no more incoming phone-calls

from the control room. This contributed to the IMT's poor situation-awareness for the remainder of the exercise.

- The IC was unwilling to brief the QMRS upon their arrival at site building hostility between the QMRS and the IC.
- Speaking too quickly and not allowing time for the data to be understood or recorded by team-members, the scribe or the person marking up the white-board.
- Poor whiteboard management including the use of shorthand (confusion over the term 'SS'), errors, poor layout, and forgetting to update it. In one IMT whiteboards were not used at all.

The behaviours observed that appeared to impact the IMT environment reducing the team-members likelihood of speaking up in the IMT:

- The IC attributed blame to a team-member when an action was not completed. *'Why's that? Just piss poor planning on your part?'*
- The IC called the IMT teams *'malingering employees'* and shouted at the underground team when data didn't come through as fast as he would have liked.
- The IC prefaced the request for a risk assessment to be completed with *'Make sure the risk assessment doesn't become a jolly'* indicating a lack of trust in their integrity.
- The IC raised his voice over others who were speaking about issues that he deemed unimportant.
- The IC ignored ideas from team-members.
- The IC shouted *'[NAME], put the fucking phone down!'* at a team-member who took a phone-call in the IMT meeting. The team-member shouted back in retaliation.
- The IC openly and abruptly reprimanded team-members and criticised their performance:
  - *'You need to be clearer!'*
  - *'OC wants spoonfed'*
  - *'If you don't catch it, write it down, don't just sit there looking dumb.'*
  - *'You should know this type of crap.'*

Participants of the post-simulation interviews generally did not criticise or discuss the behaviours listed above. Only one participant stated that the IC shouting was *'not ok'*. This possibly reflects an underlying belief that to talk about such issues would be petty and invalid.

When asked, the participants of the post-simulation interviewees described behaviours they have used, or would suggest others use to maintain open communication in the IMT:

- Be able to appease people to maintain communications when people are *'cranky and upset'*
- Tone of voice is important - remaining calm
- Never put someone down, could have said *'piss off you idiot!'*
- Be careful with words, use *'we'* rather than *'you should have'*
- Speak to people in their own language
- Talk to some people differently to others
- The way you communicate helps reflect whether you respect the person or not
- Don't attack

One IMT member explained that team members should not *'get carried away in the emotion and drama'* and need to focus on what they are told to do rather than be *'drawn into the way [someone] said it'*. He also explained that people should not become agitated with statements sounding curt or people who are rude, abrupt or pissed-off.

All of the comments above, about maintaining cooperative and respectful communications, came from members of a collaborative IMT. All spoke positively about the IC's interaction with the team; calmness, inclusiveness, thoroughness, his listening skills, his pleasant demeanour, the value he placed on team members' opinions, and the fact that he did some work himself. It is interesting that despite seeing no poor behaviour they described it, yet all but one of those who experienced hostile behaviour from the IC did not discuss it.

Another aspect of communication raised in the post-simulation interviews was, *'what kind of message you are sending when you don't send a message?'* This statement was directed at an IC's reluctance to tell the underground workers who remained in the mine, why all non-essential workers had been evacuated. Those left in the mine were obviously concerned and confused but the IC refused to brief them increasing their frustration. Another participant criticised an IC for not briefing all the members of the planning, operations and logistics groups. The interviewee believed that if the IC had conducted such a briefing the teams would have had more confidence in him.

During the simulation when IMT members stopped contributing to the IMT meeting, more than communication was affected. The IMT members appeared more focussed on the conflict than the task. For example, swift glances were shared between IMT members each time one of them was reprimanded by the IC and one team-member was observed making a fist behind the IC when the IC was verbally attacking another team-member. In the post simulation interviews one IMT member stated feeling disempowered in the IMT, and that if anyone was in doubt they certainly *'wouldn't be game to say it'*. However the team-member qualified this by saying that

IMT members *'should question the leader, even if they are having a rough day'*. This indicates that despite not speaking-up, rationally he knows that they should.

The discovery that this interviewee felt disempowered, and the observation that many of the team-members' focus was on the conflict, indicates that hostile behaviour from the IC may not only stifle open communication but affect the way people feel, think and perform. However, from these observations alone, this hostility and its effect on speaking up and conflict cannot be generalised to a real scenario because people may act differently when the risks to others are greater and the benefits of speaking-up and contributing to the process are clearer.

Errors of transmission and receipt of data

Other communication failure mechanisms were more anticipated and included errors in the transmission and receipt of verbal information such as not listening or misinterpreting or misunderstanding data. Not listening included information not being heard and information that was heard but not processed appropriately.

Communication failed because people spoke to people when their backs were turned, when the other person was walking away, or when the other people were clearly deep in thought. For example:

- The ventilation officer discussed readings of 900ppm of carbon-monoxide with the operations and planning coordinators. Following a visit to the control room he corrected himself a few minutes later by shouting across the room that it was actually 600ppm. This was altered on the planning whiteboard but not the operations whiteboard. Operations continued to base their decisions on 900ppm for a significant time after this.

At other times information was misinterpreted, for example:

- An IMT member asked the storeman (an actor) if there was any silent sealer in the stores. The response was, 'perhaps you should check'. This was interpreted as an affirmative; that there was some in the stores. This assumption spread to all functional groups when in fact there was none in the stores and they needed to order some.

Sometimes the information transmitted did not have sufficient context, the 'why' was missing and this resulted in unnecessary work on the following two occasions:

- A decision was made by the operations team to clear out the chemical store for use as a temporary mortuary. However, logistics had already ordered cold storage for this purpose. Nobody outside of the operations team department knew why the chemical store was being cleared out, and nobody outside of logistics knew that a cold-storage unit was already ordered.

- The logistics coordinator was not told that the equipment and operators he was ordering were to be used in a hazardous area, meaning that he actually needed to organise specialist operators as well as the equipment.

A general tendency not to communicate clearly often caused confusion, delays and frustration. This included issues such as mumbling, strong accents and whispering:

- Confusion arose over colloquial terms because the IMT consisted of people from different mines. Two IMT members were talking at cross purposes about *'product'* because they each had a different interpretation about what *'product'* was.

- The IC says to a team-member: *'so you would keep in contact with crews regarding gas levels'*. The team-member did not do this. It is suspected that he did not recognise this statement as an instruction.

- Upon the discovery of an incident, when the IC and others were deciding if they should call all, or only some, of the mine employees to the mine (to leave provision for a subsequent shift as per fatigue management strategies) the conversation was as follows: The IC asked a team-member to call them all in. The team-member said *'really?'*. Some moments passed. The team-member then said to the IC *'so, are we getting them in?'*, then after another period of silence *'so will we?'*. The IC replied *'so will we?'* and the team-member then said *'you're the boss'*. The IC then calls in all of the mine employees, without any further discussion, despite the original team-member, and others, seemingly disagreeing with him, but not managing to articulate it.

- A team-member came into the IMT room looking for a document that the IC happened to be reading at the time. The team-member indirectly asked if he should look at the document. The IC remained silent for a while, and then said *'was that a question?'* After a moment, the team-member asked again. The IC did not respond. The team-member walked away obviously extremely agitated and without the information he required.

- The IMT was told that a fire was *'under control'* however, this statement could be interpreted as the fire was out or that it was still burning but was contained. Similarly the IMT were told that a body had been *'recovered to the surface'*, but this did not help the IMT who needed to know where the body was. On both occasions the opportunity to discuss these issues at the appropriate IMT meeting was lost. Time was wasted while the facts were determined.

The observations above highlight the integral and reciprocal nature of communication with teamwork, leadership, situation-awareness and stress. However, the observations also highlighted the vulnerability of verbal communication to both social and cognitive processes. The communications issues discussed, despite perhaps sounding trivial, are extremely important because verbal communication is essentially what links the functional groups together in the MEMS and provides the IC with situation-awareness. If communication breaks down there is no knowledge transfer, potentially leading to inaccurate or incomplete situation-awareness and impaired decision-making.

4.3.3 Situation Awareness

The observations are discussed below in sections relating to the level of situation-awareness, that they best align with. However, it was found that these levels of situation-awareness are not necessarily discrete. Most observations related to the first Level: gathering data, because this took the most time and was a continuous activity to maintain situation-awareness of the situation. An additional topic of being aware of the incident management team has been included following comments received on the situation-awareness measure.

Gathering data

The acquisition of as much reliable information as possible, in as short a period of time as possible, is crucial to the decision-making efficiency of the IMT. The fundamental knowledge required in a mining incident is to determine if there are people involved, and if so, who they are, where they are and how they are. Yet, in all three Level 1 exercises it took an excessively long time to determine these facts. The minimum was three hours.

Given the isolation of the IMT from the incident site, often the best source of data is from those who have exited the mine shortly before or after an incident has occurred. Yet, in all three Level 1 exercises observed the debriefing process failed; the debriefing was conducted in groups; forgotten about until a few hours into the response; and completed on paper but not delivered to the IMT.

In one IMT situation-awareness was seriously impacted by the IC placing restrictions on incoming calls from the control room. The IC said that he would initiate any requests for information and as a result the IMT had very poor situation-awareness throughout the exercise. Post simulation, this IC confirmed that he didn't know what was going on outside of the IMT room.

In another exercise the IC believed the incident to be something completely different to the actual scenario. The IC had a preconceived idea and this guided his information search and influenced how he interpreted the information the IMT was given. Three hours after the incident started, as the search neared the site where he assumed the problem was, he stated *'we just need to check...'* , indicating that at this point he was still seeking validation of his theory, rather than considering other options. The IC sub-consciously failed to recognise that the data provided to the IMT did not validate his assumption. This was confirmed in a post-simulation interview. This bias was exacerbated because no-one challenged the IC's directives despite the collaborative environment in the IMT. It was only when the suspected problem area was physically reached by rescue-crews, and concrete evidence to support the assumption was not found, did the IC and IMT realised their mistake. The IMT worked with the wrong scenario for almost four hours. Within this time the potential for fatalities was not mentioned in the IMT despite evidence that a serious incident had occurred being presented in the second IMT meeting.

During the post-simulation interview, the IC explained his perspective;

> *'what you do is you're looking, and your trying, it's like trying to put a jigsaw puzzle together and some are key pieces and some aren't, and the key pieces are the ones that were like shrouded and I was looking at some of these smaller pieces that I was making them big pieces, but it's very difficult because you get this much information, and you're trying to make sense of what you've got, and like I say, as the events unfolded and some bits drifted away then the root to the cause becomes clearer.'*

This example highlights the interaction of biases that can drive 'where', 'when' and even 'if' data is sought, and then 'how' it is interpreted. Filtering of the data was a relatively common bias observed, for example an assumption was made that an increase in carbon-monoxide readings was from vehicles running close to the gas monitoring point, normalising what could have been indicative of a developing issue. In another case, the IC's previous experience, rather than interpretation of the available facts guided his management of the emergency and this delayed detection of an impending incident.

However, to complicate matters, a mining IMT can receive a lot of unsolicited information so they must undertake some filtering to help them identify the current situation. In one post-simulation interview an IC said that this was about *'establishing the facts'* and *'weeding out'* the issues and that this is a skill needed by an IC. The IC said that the amount of incoming data was too much for him alone to recall and that he relied heavily on the scribe. In another exercise the IC did not maintain a log and relied on his memory alone but as the incident progressed he was unable to recall the detail he required.

Situation awareness was also impacted by tasks to collect data not being actioned by the functional groups despite this having been being delegated. In one case, the IMT were making decisions using the wrong data because no-one was assigned to monitor the gasses.

Understanding the data

Gathering the data is the first step in the decision-making process. The data, once gathered, must be interpreted because without context and interpretation it is often meaningless.

For example, one IMT was told that all the gas monitors were reading the same high level over quite a large area. The IC's interpretation of this information lead him to instruct the team to check if the readings observed were the maximum read-out value for the equipment. It has been the case in other incidents that monitors have read the maximum read-out value when a serious incident has occurred; the gas levels are either too high for the equipment to read, or the equipment may have been damaged. Both could indicate an explosion has occurred. On another occasion an IC requested historical gas data so that this could be compared with sample results post-incident providing a normative level for comparison. This added meaning to the otherwise context-free data.

Another example of making meaning out of facts was when an IC instructed teams to back calculate, from the data available, the possible area within which a missing miner could feasibly be. In one case he suggested determining an envelope around where the man was last known to be, to determine a search area. Later, a beep on the communications system from underground was detected and it needed to be determined if this was a system anomaly or potentially the missing man i.e. could he physically have reached the location where the beep came from.

Projecting the data

The projection component of situation-awareness was often biased because it was a simulation. In all but one exercise, participants in the MEMS and Level 1 exercises assumed the scenarios would quickly develop into a crisis prior to any evidence suggesting this. One IC confirmed this, *'because it was an exercise we were anticipating that we would see it get worse and worse.'*

Only in one simulation did the IC behave how he believed he would react in reality. He was focused solely on the resumption of coal-production and unlike others, was reluctant to evacuate the mine or inform those underground that an issue may be developing. Observation alone was insufficient to determine whether or not the IC had foreseen how the incident may develop, but the situation-awareness measure revealed that the IC had predicted what may be developing but chose not to share this with the IMT.

The situation-awareness questionnaires revealed that, in general, all members of the IMTs in the MEMS courses had the same understanding of the current facts and what they meant. However, there were minor differences in when and how people predicted the situation would develop. A comparison of participants' situation-awareness with concurrent gas-monitoring data showed that both MEMS IMTs were slow to notice changes and interpret them.

Situation-awareness of the incident management team

Leading an IMT involves leading the decision-making process and leading the people managing the incident. This involves maintaining two types of situation-awareness; that of the incident and that of those managing it. The situation-awareness measure highlighted this distinction. One of the ICs used the situation-awareness measure to comment upon the IMT members in addition to the technical issues. Comments included: *'staff will come together'*, *'team feels some pressure'*. *'[team members] not always with the plan'*. This indicated that the IC was aware of his dual role of managing the team and the incident. Once he perceived that everything began running smoothly, he wrote *'team is on task'* and no further comments were made.

4.3.4 Leadership

The environment the IC creates in the IMT seemed to determine the level of support the IMT offered the IC. In both cases where the IC's behaviour was hostile the IMT were unsupportive and in one case rallied together in defiance against him. However, it cannot be claimed that

one leadership style is necessarily better than another because there were also issues with collaborative IMTs' decision-making processes. These included team-members not speaking up despite being encouraged to do so, discussions rarely being concluded and few decisions being made and implemented.

Further, the utility of a certain leadership style seems dependent on the IMT members' reaction to it. For example, when an IC swore at a team-member and the team-member shouted back, both parties and the IMT resumed normal interaction immediately afterwards. However, when another team-member was treated similarly by the IC he withdrew and failed to actively contribute to the IMT from that point forward. The ICs behaviour was consistent, it was how the team-members reacted to it that determined the success or otherwise of the team. Indeed, the IC of the IMT that withdrew complained that his team were too compliant and needed to be more confident. Therefore, evaluation of good leadership is subjective and successful leadership is dependent on the team's reaction to the IC's behaviour and their resulting followership.

4.3.5 Teamwork

Following the incident where the IMT members seemed to rally in defiance against the IC, one team member explained that he believed the IC's behaviour led to stronger teamwork between the functional teams. A similar *'us and them'* situation was observed in a familiarisation MEMS observation where two of the functional groups became competitive and started openly blaming each other for the deficiencies in the overall performance. This indicates that intergroup conflict, as well as interpersonal conflict may impact IMT performance.

'Conflict solving', an element of teamwork in the aviation behavioural marking system, and adopted in the mining specific observation template, seems particularly applicable to the mining IMT. The aviation taxonomy cites: keeping calm, suggesting conflict solutions, and concentrating on what is wrong rather than who is wrong as behaviours that minimise conflict. In contrast: shouting, withdrawal of cooperation and a strong blame culture was evident in several of the mine emergency simulations.

The hierarchical nature of MEMS was observed to be potentially detrimental to teamwork. Team-members were heard to say *'you're the boss'* on two occasions. In one scenario the team-member seemed to want to offload his responsibility and in the other scenario, it was possibly to minimise conflict with the IC. This indicates that they were using the hierarchical nature of the command and control structure to shed responsibility and avoid open discussion about conflicting opinions minimising collaboration and many of the benefits of teamwork.

During MEMS simulations there was often confusion regarding the differentiation between the roles of the planning group and the operations group which was corrected by the MEMS coordinator. This indicates that training is required if MEMS is to be implemented as it is intended.

4.3.6 Assertiveness

Due to the mining IMTs reliance on verbal communication, assertiveness issues are potentially important. The observations of team-members not speaking up when they disagreed with the IC or didn't understand the tasks they were given indicates that assertiveness may be an issue. However, it seems more likely that multiple issues drove the desire to stay quiet, including the hostile IMT environment, fear of being humiliated, being overloaded, being observed by assessors and interpersonal conflict.

4.3.7 Stress and Fatigue Management

Stress was observed as a result of: work overload; due to the constant ringing of phones in the IMT; when delays meant that the response was not progressing; when people felt they were not being listened to; and when they were spoken to in a manner that they felt was inappropriate.

An observation that may have indicated stress in the functional groups included a number of team members gathered around a whiteboard discussing a pipework connection. The solutions being discussed were not particularly technical and their behaviour was casual, *'it's so easy, just go to Bunnings and get silicone sealer'*. They all appeared to enjoy this discussion and all jostled to contribute. They spent time working through different strategies and there was not the usual break off from the group observed in previous discussions. Their relaxed demeanour and their reluctance to move on and deal with more pressing issues, may have been indicative of them temporarily relieving their stress at this time. However, this could also have been the result of fatigue, boredom or frustration. There was no other evidence of fatigue observed in the simulations.

4.3.8 Emotion

Emotion resulting from poor social-interaction was the only emotion observed in the Level 1 and MEMS simulations. The petulant and uncommunicative behaviour of one IMT member may have been an emotional reaction to the shouting, blaming and belittling tactics used by an IC, or alternatively an emotional reaction to not having the required technical skills. Similar behaviour was observed in team-members who were overloaded or who were not being listened to.

Perhaps of more concern was the lack of emotion and urgency observed in any of the three Level 1 exercises when there were miners unaccounted for underground, possibly injured or dead. In one Level 1 exercise it was temporarily believed that one miner had been exposed to a potentially fatal concentration of CO yet no urgency or emotion was apparent. In another IMT, the fact that three miners may be dead or dying underground, was not mentioned in the IMT at all. It is unlikely this would be the case in a real scenario, as one Level 1 post-simulation interviewee explained, *'we would all have been having chest pains. I mean it would have been*

absolutely catastrophic even the fact they were missing. And clearly we didn't respond like that.'

4.3.9 Trust

Two statements made by an IC; *'Make sure the risk assessment doesn't become a jolly'* and calling those working for the IMT *'malingering employees'* possibly contributed to the IMT's negative reaction towards him. These statements possibly reveal more about the IC's personality rather than actual levels of trust. However, it seems likely that these statements were found particularly offensive because they implied a lack of trust in the workers integrity.

4.3.10 Personal Strengths and Limitations

In the mining context, personal limitations must include a lack of technical skills and this is an issue not addressed in previous non-technical skills literature because the decision-makers have been assumed to be technical experts. However, mine-managers may not have the specific technical skills required to make technical decisions in a particular incident and may be reliant on their teams' or external experts' knowledge. The observations clearly revealed the interrelatedness of technical and non-technical skills and associated behaviours. For instance, a less experienced IC had to be collaborative because he didn't have the technical skills required and wanted the security of his team standing by him should things go wrong. In the post-simulation interview this IC stated that at one point he *'probably panicked a little bit'* when he hastily made a decision, and he acknowledged that *'it was a big help having them [the IMT] contribute their thoughts, and all of them challenging why this and why that'*. He stated that this collaboration helped him revise his inappropriate and hastily made decision. A team-member in this IMT stated that in a real scenario this IC would need to be more direct and set clearer expectations and another stated that if the IC had more technical skills he would have been more confident in the decision-making.

A key personal strength or limitation appears to be self-confidence. This is likely to be at least partially dependent on real and perceived technical skills. There is obviously the potential to over and under-estimate one's own skills but even for the most technically competent, the combination of stress; fatigue; overload; an unfamiliar, rapidly changing and emotive environment; and the pressure of making life and death decisions, could seriously undermine their ability, or their confidence in their ability, to apply their technical skills.

Confidence or over-confidence may have driven the behaviour of the two ICs who were dismissive and disrespectful to their teams because they possibly believed they had the skills, and were therefore confident that they could handle the incident on their own.

4.4 Discussion

The observations revealed the over-simplification of considering situation-awareness and decision-making as discrete categories, with a linear, one-way and dependent relationship between situational-awareness to decision-making. Acquiring situation-awareness involved many sub-decisions to direct data-gathering, to validate data, to understand data and to decide what information was relevant. This is in line with Brehmer's description of dynamic decision-making where many decisions are made to maintain control, rather than to achieve goals, in real-life situations [18]. Much time was spent in IMTs determining what data was required, organising the physical collection of the data, understanding the data, monitoring changes to the data, re-evaluating the meaning of the data and providing instruction to the team. As the scenarios progressed, the IMTs often seemed to simply be trying to catch up with what was happening in the mine.

If a linear process is assumed, from situation-awareness to decision-making, it would mean that situation-awareness must be achieved prior to decision-making occurring. This then leads to the question, 'what is situation-awareness in a mine?' If it is assumed that situation awareness means working out what has happened in the mine, i.e. the details of the incident, in many cases this would severely restrict decision-making. It could be said that no-one at Pike River had situation-awareness during the rescue and recovery stage because it took two years to determine what most likely caused the blast. This definition is therefore idealistic, and a more useful definition, that would enable IMTs to make progress, is having an understanding of the most likely current and future state of the situation underground with the recognition that it is a dynamic state and interrelated with the sub-decisions made within the process of acquiring situation-awareness.

Situation awareness is not binary, it is not a matter of having it or not, there will always be some situation-awareness, and some decisions will need to be made before complete situation-awareness is achieved. Decisions with high impact consequences, such as the re-entry decision, require more certainty surrounding the situation-awareness than decisions of less consequence, say those regarding potential contingency plans for a future time. For example, it is clear that the re-entry decision is one where any uncertainty regarding the safety of the mine is deemed unacceptable. Therefore, the acceptability of the level of uncertainty surrounding the situation-awareness is a decision in itself and is determined by the severity of the consequences of any decisions to be based on it. If no decisions could be made without complete and accurate situation-awareness during a mine emergency response then few, if any, decisions could be made. This may be an issue the root of the problem of delayed decision making. However, it must be acknowledged that without adequate situation awareness there is only a slim chance the correct decision and accurate, and conversely, complete situation-awareness does not guarantee a good decision.

The observations exposed an assumption that the researcher had made previously from

reading the mining literature, that there are only one or two 'big' decisions IMTs need to make. Prior to the observations, this assumption overshadowed the recognition that lots of 'smaller' decisions must be made throughout the emergency-management, for example how to achieve situation-awareness, and that therefore the relationship between situation-awareness and decision-making is reciprocal. This means that the decision-making process in the mining IMT, is not a singular and isolated activity within the IMT. It is much larger and less constrained than was assumed because it is an evolving and social process that is reliant on the technical, social and cognitive skills of the people within the IMT, and outside of it, who contribute knowledge to the IMT.

The decision-making process was observed to be heavily dependent on communication, leadership and teamwork to provide the IMT with sufficient information to develop situation awareness. The observations highlighted that communication is essential to the IMT process yet that it was also the weakest link due to the prevalence of interpersonal and intergroup conflict issues. Communication failure was commonly observed and this impacted IMT performance generally by causing delays because information was either not exchanged or people did not challenge the assumptions of others at the appropriate time. Not speaking-up resulted in confirmation bias going unchecked for several hours. As a result, the issues of interpersonal and intergroup conflict seem to require more attention than the previous literature would suggest because its impact on communication can mean that data gets lost or delayed, biases can thrive and tasks can remain undone.

Different decision-making techniques were observed including: following heuristic rules; following checklists and guidelines; and developing creative solutions. Detecting intuitive decision-making from observation alone was difficult meaning that the lack of examples may be a function of its invisibility, rather than being indicative that it does not occur.

A significant observation was the impact the IC has on the functioning of the IMT. When ICs were cool and calm, so was the team and communication was more open. When ICs were arrogant, and sometimes offensive, the IMT generally failed to communicate and act in a helpful manner. This supports previous research that rudeness can affect helpfulness, cognitive functioning and creativity [164], with the proviso that performance is dependent on the team-members' reactions to the IC's behaviour [64]. However, a cool and calm IMT was not sufficient, on its own, to ensure an open and collaborative decision-making process because people still did not necessarily speak-up. Similarly, an autocratic IC does not automatically lead to poor performance as long as the team can resist the tendency to take the IC's behaviour personally and get on with the job.

Participants of the Level 1 exercises seemed to understand the purpose of exercise as a test of the mine's emergency response plan, and their own individual ability to stick to and complete the tasks prescribed by it. At one Level 1 exercise, prior to the start of an incident, the researcher observed one man 'swatting-up' on procedures. In all cases fresh mine plans were on the IMT tables and the policies and procedures had been recently revised. The behaviour of the

participants was characteristic of people showing that they were following due process and that their documentation was sufficient, rather than being representative of what would actually happen if colleagues were missing. A similar issue was identified in the training of offshore installation managers, they were assumed to be competent following experience in simulations, yet the simulations only encompassed the use of company emergency management procedures where 'Time pressure, incomplete information, or life and death issues are not present' ([186, p. 130]).

Due to the fact that the observations were of simulations only, it is likely that some of the behaviours observed were not representative of those that may occur in a real life IMT. For example, in all but one case, the ICs and IMTs were trying to predict what tricks and twists the scenario might entail rather than only using the available facts. In addition, no stress or emotion was evident in the exercises as a result of the life and death nature of the incidents. Therefore, it is clear that the Level 1 exercises did not have sufficient psychological fidelity to initiate all of the issues that may impact decision-making in a real IMT, evidenced by the lack of urgency when people were missing and more than likely dying. This means that reliance on the Level 1 exercises alone to determine the issues that may impact IMT decision-making is insufficient. Thus the next phase of this research involved finding and interviewing the small number of mining personnel who have had real-life experience in mining IMTs to provide insight into the issues that they have seen affect decision-making in real mining emergency situations.

5 Interviews: Real Mining IMT Experiences

5.1 Introduction

The primary goal of this research is to determine the role non-technical issues play in decision-making during the management of an emergency at an underground coal mine. Chapter two examined related academic and mining literature; chapter three explored Level 1 mine emergency exercise reports and determined the role that some non-technical issues may have on mining IMT decision-making; and chapter four built on this by discussing the non-technical issues that were observed by the researcher during emergency exercises. This chapter examines data captured via interviews with individuals who have experienced decision-making during real-life coal mining emergencies.

Twenty five men who have been involved in mining emergency IMTs were interviewed using a semi-structured and conversational style interview technique to obtain a detailed understanding of their experiences with non-technical issues during these events. A taxonomy of non-technical issues is presented to summarise the findings and provide the basis for recommendations and future research.

5.2 Method

5.2.1 Recruitment of interviewees

Purposeful sampling [159] was undertaken to recruit individuals who had experience in a serious real-life IMT as a mine employee/contractor, a mines rescue member or a Government representative. Potential interviewees were identified at MEMS courses and during the 2012 Level 1 planning trips. Snowballing sampling [15] was used throughout, whereby the interviewees were asked if they could suggest others that had relevant experience.

5.2.2 Participants

Twenty-five participants with real-life IMT experience were interviewed. Fifteen had been involved in incidents involving one or more fatalities. Ten of those people had involvement in the IMT at the Pike River Mine, and seven of these ten had experience with fatalities prior to the Pike River incident. All participants were employed in mining related roles in Australia or New Zealand at the time of the interview. All were male, and had between 10 and 55 years of experience in the mining industry. The participants' average number of years in the mining

industry was 33 years. Table 5.1 shows a breakdown of years' experience by employment status.

Table 5.1: Coal mining experience by employment status

	Number of Participants	% of Participants	Average experience (years)
Employee of mining company/contracting company	12	46	36
Employee of a mines rescue service (NSW,Qld or NZ)	9	36	29
Government representative	4	18	33
Total	25	100	33

Only four participants had less than 25 years mining experience and each of these were involved in the Pike River IMT. The age of participants ranged from mid-40s to mid-70s. The incidents discussed spanned the years 1972 to 2011 and occurred in four countries; Australia, New Zealand, the United Kingdom, and Africa.

5.2.3 Interview overview

A semi-structured conversational interview style was adopted for the interviews in which 'researcher and participants are viewed as partners, collaborators, or co-constructors' [22, p. 64]. This method of interview has been used in previous mining studies to obtain more candid and insightful responses than those achieved by structured interviews [82].

Although the details of decision-making at particular incidents may have been obscured by the fog of time, these men's recollection and interpretation of their experiences and the emotional and physical environment of a coal mining emergency is a real, rich and valid data source for understanding the non-technical issues that may impede decision-making in a mining IMT.

In some cases the interviewees had not thought in detail, or ever spoken about these issues, before the interview. However, the opposite was also true. Some participants who were involved in the Pike River commission were very well practiced at providing factual and objective accounts of their involvement there. Both sets of interviewees struggled to articulate what seemed, to them, to be subjective and nebulous concepts. The meaning of the behaviours the participants had observed and the decisions they had made, or had seen made by others, were discussed and negotiated to provide a rich understanding of the non-technical issues. By negotiating the meaning within the interviews and then discussing and negotiating these meanings with others in subsequent interviews a more thorough and complete picture was obtained [34].

5.2.4 Procedure

Employees of the Queensland and NSW mines rescue services, and those who worked at underground coal mines in the Bowen Basin, were generally interviewed at their workplace. Three trips were made to the Bowen Basin between September and October 2012. The participants working at the mines held senior management roles and their availability was limited and unpredictable. Interviews were consequently conducted whenever and wherever possible as long as the location enabled privacy and was quiet enough to ensure a clear audio recording. Locations included corporate offices, hotel rooms, homes and quiet restaurants. Interviews were conducted in Newcastle, Brisbane, Emerald, Mackay, Dysart, Blackwater, Middlemount and the Bowen Basin coal mines between 25 September 2012 and 26 March 2013.

Conducting interviews

Participants were thanked for their time and provided informed consent. The interview was then conducted in two parts: Part 1: This involved the participant talking through a difficult, or otherwise memorable, decision that they had participated in making in an IMT. During this period the interviewee was not interrupted and the researcher formulated questions relating to non-technical issues that were implied in their narrative. These questions were asked at the end of the interviewee's narrative. Probes from the interview template were also used to access relevant non-technical issues. The probes included hypothetical questions and those directed at specific non-technical issues e.g. *'How do you think someone with less experience might have handled that situation' and 'What was your understanding of the situation based on?'*.

Allowing the participants an uninterrupted opportunity to speak freely allowed them to present their 'press release' early on [221].This is a term used to describe what the participant wants to say, based on what they believe is the truth and how they want to be perceived. This 'truth' however is driven by the socio-cultural context of the industry and the interview itself. The initial narrative allowed the researcher to gauge the participants' overall and unprompted attitudes towards the issue.

The initial questioning based on their narratives helped the interviewees to understand the focus of the research and enabled them to keep on track as the term 'non-technical' can be, and was, interpreted in many ways. It was also useful in establishing trust and rapport.

During this initial component of the interview, where there was uncertainty from both parties about the utility of the impending interview, the power was negotiated. Power issues are integral to the interviewing process [120]. The researcher was often tested by the interviewees in terms of technical knowledge, or general worthiness of the interviewee's time. During Part 1, the researcher could indicate her understanding through nods and acknowledgement throughout the participant's own story. The men being interviewed were generally senior in age and in their status within their company, holding significant responsibility for production and safety at their mine. The researcher had much less status than the interviewees being younger, female

and a student.

Immersion in the industry for the previous 18 months of the research, and in particular learning the extensive and unique mining terminology, proved vital to the success of the interviews. However, in some cases the researcher deliberately disclosed the fact the she was a Chartered Professional Engineer to help re-balance the power and move the interview towards a more useful and egalitarian conversation. Self-disclosure for the purpose of establishing rapport and trust with the participants is as an integral part of accessing good quality qualitative data using interviews [129]. This was evident by participants revealing more personal accounts of their experiences later in the interviews once trust and rapport had been established. In one case, a participant admitted that he had deliberately withheld a pertinent detail earlier. For those interviewees who had recently assisted in the rescue and recovery stage at Pike River, the details of the decision-making could be discussed in more detail due to the recency of the event.

Part 2: Participants were asked specifically whether they could recall an incident when a particular non-technical issue, such as fatigue or emotion had impacted on the IMT's decision-making. The non-technical issues addressed in turn were leadership, teamwork, stress, fatigue, emotion, trust, personal limitations, assertiveness, communication and emotion. 'Caring' and 'respect' were included after the third interview because all three participants had raised these issues independently.

However, Part 1 generally resulted in a deep discussion covering all of the non-technical issues from the participant's own experience meaning that Part 2 was not employed in full. Part 2 was mostly used to confirm the researcher's understanding of the participant's understanding of the role of each non-technical issue.

On completion of the interview, participants were asked if they knew of anyone else that would be valuable to interview. The duration of the interviews ranged from forty minutes to five hours. The average length of the interviews was one hour and fifty-five minutes.

Data Analysis

The researcher transcribed each interview. A total of 48 hours and 254 thousand words were transcribed using the audio recording from a Live-scribe Echo pen. The Live-scribe desktop software enabled the researcher to view the notes written during the interview, in PDF form, whilst the audio recording played simultaneously. When names of people, mines, incidents or companies would compromise a participant's anonymity they were replaced with [name] or [role], [mine], [incident] or [company] to aid comprehension. Some exceptions were made whilst transcribing interviews from people who attended Pike River, when retaining names or roles added to meaning to the data, e.g. different people speaking about the same decision being made, however these details are not included in the thesis. The transcripts were formatted prior to input into NVivo to ensure that interviewee text was easily distinguishable from the interviewer text during analysis. Each interviewee, and corresponding transcript file, was given

a unique and random identity code that had no link to the participant's name, location or the date of the interview.

Framework analysis [214] was used to analyse the data because of its logical progression towards developing theories by first identifying themes in the data. Framework analysis consists of five steps [214]:

1. Familiarisation
2. Identification of recurrent and important themes
3. Indexing and pilot charting
4. Summarising data in analytical framework
5. Synthesising data by mapping and interpreting.

The methods used within each step are case specific. It is the overall structure of framework analysis that provides the level of rigour that enables transparency throughout the development of the themes and theory. The methods used in this research for each step are outlined below.

Step 1: Familiarisation

This step is also referred to as immersion in the data. This was achieved by conducting the interviews and transcribing them. For this research it was important to understand each of the interviews as a whole before dissecting them into relevant themes for cross comparison. This was achieved by creating individual excel workbooks, writing a memo and drawing mind maps for each participant which documented the issues that they felt most strongly about. A visual representation of each interview as a whole was drawn and proved useful to remind the researcher of the context from which the components had been extracted in later analysis.

Understanding each of the individual's beliefs was vital because each participant's views are valid data in their own right. This deep understanding of each of the participants' beliefs prior to comparing responses between participants enabled a more meaningful analysis [22].

Step 2: Developing a theoretical framework by identifying recurrent and important themes

The data were initially structured by creating a workbook in Excel for each participant that captured all of the data relevant to that participant. The participant workbooks contained 7 template worksheets:

Sheet 1 - Instructions: This sheet was included to ensure the researcher to followed the same procedure for each participant.

Sheet 2 - Memo for participant: Memos are a useful part of data analysis to capture any in depth thoughts the researcher has when looking at the data [34]. This sheet contained details specific to the particular interviewee and in many cases diagrams were also drawn and these were stored with the paper mind maps.

Sheet 3 - Demographic information: This included the participants number of years in coal mining, involvement in mines rescue, employments status, experience in emergency services, and the level of involvement they had in IMTs.

Sheet 4 - Non-technical issues sheet: An initial set of recurring themes was input into a template and alongside these a summary of what the participant had said about each was input. The initial theme list was relatively comprehensive to limit the need to add new themes later and minimise the need to retrospectively re-assess already summarised transcripts. The mind-maps (created in Step 1) were used to assist the completion of this worksheet.

Sheet 5 - Decision sheet: Details were recorded about a specific decision if one had been identified. It included prompts to determine what could have affected a decision, the category of non-technical issues that possibly affected the decision, what the decision was that it potentially affected, whether the non-technical issues did in fact impact the decision and if the outcome was successful.

Sheet 6 - Unprompted: This sheet was reserved for themes that the interviewee brought up unprompted and felt particularly strongly about. This was included as a reminder, like the mind map (Step 1), of which issues were pertinent to the interviewee. For instance some would blame all poor decisions on a dominant IC, while others might blame everything on a poor data collection system. Knowing the mantra of the interviewee was useful to interpret their comments.

Development of the workbook was important to ensure an intimate knowledge of the themes important to each participant. The essence of their viewpoints was captured, whether positive or negative, without being buried in the superfluous words of a transcript. Further, this standard set of worksheets for each participant enabled them to be easily merged to form a master workbook containing all the data from all of the participants in six master worksheets. Master worksheet 4 contained all of the non-technical themes from each participant meaning that all of the themes that one participant discussed could be skimmed by reading along a row, and a snapshot of what all of the participants said about one particular non-technical theme could be accessed by reading down the relevant column. This initial sorting informed the themes input into in NVivo for the next stage in the analysis.

Step 3: Indexing and pilot charting

The transcripts and the themes from the master workbook were imported into NVivo. Defining the themes and sub-themes that emerged in the data was an iterative process and changes were made during the analysis. The sub-themes input into NVivo were detailed, rather than broad allowing the option of amalgamating them into larger groups later. Participant demographics were input, as were codes for unprompted statements, statements relating to Level 1 exercises, Pike River references and researcher and participant speech.

The transcripts were re-read twice during this stage. The transcript was first read alongside the field notes, mind maps and memos and any comments that the researcher had annotated on the transcript relating to a particular statement made by the participant. The transcripts were also re-checked for anonymity and if the intention of any statements were unclear, the audio recording was accessed to confirm it.

During the second reading, statements made by participants were assigned to the relevant themes or sub-themes that had been input into NVivo. This is commonly termed thematic-coding [34]. When a comment was obviously related to a sub-theme, it was placed there, if it related to an overarching theme but not directly relevant to an existing sub-theme it was coded to the over-arching theme for distribution later if a new sub-theme became warranted because similar statements had been made by others. This meant that the number of sub-themes grew slightly during the coding exercise. Any themes or sub-themes added during this phase meant the transcripts had to be retrospectively coded for the new sub-theme. Each statement was coded to all of the themes and sub-themes it related to, for example, the following paragraph was coded to stress, self-confidence, leadership and situation-awareness.

> *'Oh and I'll tell you another thing I have seen where the IC wants to rely too heavily on, you know, 'what do you think?', what do you think?', then all of a sudden he's running off on tangents, he's getting ideas from everywhere, I've seen that a number of times and there's a lack of confidence. Stress causes a lack of confidence. And he's clutching at straws. That's probably one of the bigger ones I think I've seen.'*

Step 4: Summarising the data in an analytical framework

At this stage the themes and sub-themes were re-assessed. Several themes and sub-themes were moved or combined with others to enable a more streamlined overview. Once all transcripts were coded some themes seemed more suited to be a sub-theme of another. For instance, 'agenda', was originally an independent theme due to the frequent number of times interviewees spoke of it, but was moved to become a sub-theme of trust because it appeared the root cause of many trust issues. The analytical framework (how statements were coded) within NVivo at this stage was a representation of how the researcher believed the data fitted best at that time. It was a subjective process intended to capture the essence of the interviews by using the interviewees' terminology for the names of themes and sub-themes. This form of analytical reductionism is essentially false and distorts the relationships between the themes. However, for 'convenience of analysis' [118, p. 37], the distinction between themes was made based on a knowledge of the data. Creating high level themes or categories at this stage was seen as having limited value and the researcher felt that it could potentially result in over simplification of the data before it was fully interrogated. For example, at the higher level (the themes) teamwork and leadership are just as likely to be important in mining as they are in other industries. Therefore, it is the detail within these themes, the sub-themes, that is important and captures

the useful and unique information relevant to the mining emergency environment. This issue of oversimplification was encountered inadvertently with the leadership theme. No sub-themes were initially assigned to leadership and then when leadership was analysed the process of breaking it into elements was difficult because most of statements coded to leadership were already coded to other themes or sub-themes. This highlighted the broad nature of IMT leadership.

Step 5: Synthesising the data by mapping and interpreting

This is the stage where theories can be developed from analysis of the data. *'Theorizing is interpretive and entails not only condensing raw data into concepts but also arranging the concepts into a logical, systematic explanatory scheme.'* [34, p. 56] This was achieved by the development of a non-technical issues taxonomy for decision-making in mining IMTs. This taxonomy could be used to inform industry recommendations and future research. Each of the sub-themes was analysed individually referring back to the raw data in the NVivo, the excel master-spreadsheet, the memos, and the mind maps, to fully understand the concepts that the interviewees were describing. The framework outlines these in terms of non-technical issues categories and elements.

The participants' general understanding of the decision-making process, and how non-technical issues influence it is discussed first, followed by the presentation of a taxonomy of non-technical issues as they apply to decision-making in a mining IMT. The subsequent sections provide a detailed explanation of each category and element within the taxonomy.

5.3 Results

5.3.1 Decision-making in the IMT

Several conclusions can be drawn from the interviews about mining IMT decision-making:

- IMT decision-making is highly reliant on accurate and complete situation awareness .
- The large number of decisions IMTs make are rarely recognised.
- There is a strong belief that only objective decisions can be good decisions.
- Most interviewees believed decision-making ability is an inherent personality trait.
- IMT decision-makers use multiple decision-making methods.
- The mining IMT emergency decision-making process encompasses a broad psycho-socio-technical process that can impact decision-making directly, or indirectly, due to its reliance on situation awareness.

Many decisions are made throughout a mine emergency management operation. Decisions are made to work out who is underground, what has happened, what is happening underground,

who to involve in the IMT, and who or what organisations should be called for assistance. Each individual involved and each of their psychological and physiological reactions to the situation, and to other members of the team, can influence the IMT decision-making process. IMT decision-making is a broad and social process and includes everything and everyone that is associated with it, including the emergency environment itself. The cognitive information-processing type decision-making processes described by traditional decision-making research form only a tiny part of a mining IMTs decision-making process.

This broader definition of decision-making was borne out of the realisation that each of the interviewees' comments about decision-making could also be coded to at least one other non-technical issue, highlighting the inter-dependency of decision-making and non-technical issues in the mining context.

In contrast, when interviewees were asked specifically about the decision-making process, they were less able to articulate their thoughts and generally spoke of maintaining objectivity and validity. This suggests that the participants understood the decision-making process to be a narrower and more discrete process possibly involving analytical and procedural methods.

Many interviewees failed to recognise the large number of decisions made in a mining IMT. There are three potential reasons for this. It could be because life or death decisions, such as the re-entry decision, overshadow any acknowledgement of the strategic and logistical decisions that must be made throughout the operation. This is partly evidenced by the assertion of several interviewees that the formation of an IMT is almost useless because any decisions it could make would have no bearing on the survivability of those underground.

> *'Well you know what, once the incident has occurred, I think it's too late to be quite honest at times.'*

> *'As a matter of fact the IMT would probably only sort of come into its way in about the next 4 to 6 hours after the accident occurs. And by that time it's either just stabilising or body bags. To be crude, but that's what it is.'*

Alternatively the lack of recognition of decision-making could be because few significant decisions have been observed. In previous incidents, and exercises, decision-making has often been delayed until the point it becomes irrelevant because the incident situation has naturally developed into the next stage.

> *'A lot of times in ICT people don't tend to make decisions, in some cases it will just sort of happen.'*

> *'I think it's almost a fear thing I think. Like it's, they are afraid of exposure. It's almost like the ostrich with its head in the sand, it will all go away soon, I'll pop my head up and it will all be gone.'*

> *'There's a lot of people who don't make decisions, they procrastinate. Well if I don't make a decision within a day it will go away anyway. You can't do that in an emergency.'*

Thirdly, some decisions may not be recognised because they are 'intuitive', meaning that they are not the result of an overt and cognitively intense analytical process. In other words, if options have not been generated, discussed and evaluated within the IMT, the outcome may not be recognised as a decision or may simply not be recalled because limited cognitive processing occurred. The industry belief that analytical decision-making is the only truly valid and objective way to make a decision in an IMT no doubt exacerbates this decision blindness.

'I think decision-making is about just taking the obvious course of action.'

'Not really a decision 'not really an option, it's a must do.'

In contrast to many interviewees, one participant who was an IC following a serious incident where there were no injuries but there was contention regarding re-entry of the mine, was able to articulate that he was making *'judgements and decisions' 'all the time'*. Many of the decisions he had to make were not technical. They were about the people involved; deciding how to give them assurances that he (the IC) hadn't given up on the mine, deciding on how best to communicate with staff in terms of when and where, but also how to personally deliver bad or good news, deciding how much information to share and deciding who should be in the IMT. He had to decide who he wanted technical and strategic help from, how best to use their help and how to handle the existing relationships between the external agencies who became involved whilst maintaining his position of authority. He had to decide how best to deal with the psychological and physiological stresses that became evident in the team including deciding when it was time to send people home to be with their families because they were becoming too fatigued. He had to decide how to manage the personalities and emotions of those involved to minimise disruption and maintain focus on the objectives. Without these decisions, the chances of an optimal outcome were unlikely.

> *'It's actually your ability to manage people, manage process, manage a situation and listen to all of the information to be able to make the right decision with the right advice. That is so situational.'*

An incident controller's leadership and decision-making skills were commonly attributed to his personality. In general, interviewees held black and white beliefs about decision-making skills; That people either can or can't make decisions. *'There are people that shouldn't be allowed anywhere near decision-making'*. Others offered accounts of people *'freezing'* and being unable to make decisions. *'I think it's in their nature, it's in their personality or whatever you want to call it.'*

ICs that don't make decisions were often believed to have a personality that fears the personal consequences of making a wrong decision. *'To make a decision for them is threatening. And so they will avoid making the decision'*.

Good decision-making ability was strongly associated with having a courageous personality, a willingness to take responsibility and also masculinity, several interviewees likening making a decision to putting their *'old fella'* or *'balls'* on the block. These traits were believed by some to be typical of a mine manger's personality.

> *'I think that's a trait of a mine-manager. If you are the type of person that's afraid to make a decision, and frightened of the repercussions, I might go to jail, the inspectorate might, I might end up in the dock at court, you'll never ever get to that position, because you just physically won't because your anxieties will stop you. So the people that do get to those positions, are people who can, wipe it. Risk-take I guess, in a way. Prepared to take that level of responsibility and the possible repercussions. If you are not, you'll never get there so there is that it will never happen to me.'*

The interviews revealed that the mining IMT decision-making process is not simply the cognitive or collaborative process that occurs in the isolated IMT room upon receipt of accurate, and complete data, as the traditional models of decision-making imply. The decision-making process is highly social and relies on many people to provide the decision-makers with accurate information, and for the decision-makers to then be able to interpret and process this information correctly to develop situation-awareness.

> *'The decision-making really isn't about that, it's about getting a group of people to focus and function. It's got nothing to do with the technical stuff really, well, you've got to know what you are talking about but it's more about handling your people. Which is not what miners do best I guess.'*

The narratives also indicated that the participants have undertaken or observed different types of decision-making methods in real IMTs including the choice, intuitive, rule based and creative methods of decision-making outlined by Flin [73]. The type of method chosen seems dependent on the situation. For example, the re-entry decision is one that was understood to require full analysis and adherence to the QMRS re-entry guidelines. In the situation where an IC had to decide how to impart bad news to mine employees, this was undertaken using intuition. In other cases, where there were no precedents, creative decision-making tactics were used but this seems a specialised skill.

> *'you can give someone all the CDs, you can show them what happens, but the people that make extremely good leaders in most cases are the people that are able to analyse what's happening and make a decision on about something that they've not seen before using information they've got in their mind. So they piece things together. Some people can't do that.'*

In summary, to accurately portray the IMT decision-making process, consideration must be given to the vast number of social and cognitive issues that can influence it. The process is

not simply a consideration of a number of options, it is not confined to the IMT room and it is not independent of the people in the process. The IMT decision-making starts when the first piece of information is discovered that indicates something out of the ordinary has happened and only ends when the final IMT decision has been implemented by the teams. Each and every person involved in that process, their social interactions and their psychological and physiological states can influence the IMT decision-making process.

In an attempt to clarify and explain the many non-technical issues that the interviewees believe have impacted decision-making, a taxonomy of non-technical issues has been developed. This framework can be seen in Table 5.2 below and contains categories and elements that summarise the many behaviours, feelings and attitudes that the interviewees have experienced or witnessed impact IMT decision-making. These are described in detail in the subsequent sections.

5.3.2 Situation Awareness

IMT decision-making relies on having an accurate understanding of the current and potential future state of the underground-mine. However, the information on which situation awareness is based is primarily supplied to the key decision-makers in the IMT by verbal communication. It is this that makes the acquisition of situation-awareness in the mining IMT a social and cognitive process as well as a technical process.

In addition, the IC must also maintain awareness of the incident management operation. This involves monitoring the progress of the teams and how they are coping. In a protracted response it is critical to ensure that the IMT and wider team remains focussed and do not burn-out. Coordination is required to deal with the media, families and external agencies providing assistance such as the emergency services, the Mines Inspectorate and perhaps other organisations like the Red Cross. In this case, an understanding of the emergency management environment, and how people are likely to behave within it would be beneficial.

Hence, two distinct types of situation-awareness are relevant to the mining IMT:

- Obtaining and maintaining situation awareness of the incident and the conditions in the underground mine.
- Maintaining situation awareness of the emergency management operation (above-ground), including the IMT members, the mine-workers, external stakeholders, the media and the assisting agencies.

This understanding has guided the taxonomy development. The three stages of situation-awareness of the incident will be discussed first, followed by situation-awareness of the emergency management operation.

Table 5.2: The decision making non-technical issues taxonomy

Category	Element
Situation Awareness	Incident - situation awareness
	Gathering Information
	- Debriefing
	- Validation
	Understanding the information
	Projection
	Emergency management operation - situation awareness
Collaboration and Cooperation	Selecting the 'right' team
	Interpersonal conflict
	Inter-group and inter-agency issues
	Roles and responsibilities
	Maintaining focus on the objectives
Trusting others	Trusting and having confidence in others
	Having an agenda
	Respecting others
Caring for others	Caring for the IMT
	Compassion for those close to the incident:
	- The mine workers
	- Dealing with families
Personal strengths and limitations	Recognising and dealing with environmental stressors
	Recognising and coping one's own emotion and stress
	Recognising and coping with others' emotion and stress
	Fatigue
	Self-confidence
Maintaining open communication in the IMT	To challenge and be challenged
	Creating an environment where people can speak-up
	The communication transaction
	How to speak to team-members
Leadership	Remain calm and confident
	Communicating externally from the IMT
	Delegation vs micromanagement
	Reprimanding team-members

Situation awareness of the incident - Gathering information

There is no doubt that having accurate situation-awareness is critical to maximise the chances of a successful decision being made.

> *'The fact is, your situation awareness, it's right here, right now, and it's how to make sense of all that information, and it's the quality of the decision you are about to make. So it's about understanding that context, it's about understanding what the competing goals are. Why is it? I don't care about what happened in the past, I can't be biased from that, I can't use that because it worked for me in the past, I'm right here right now, what do I need to do to take a step forward. So it's understanding that process and you just cannot afford to be biased either way, forward or backward. So your prejudices, you need to make sure your decision is valid.'*

Significant evidence was presented by the interviewees to suggest that trust, communication, biases, leadership, fatigue, social factors, self-confidence and stress were integral to the process of deriving and maintaining situation-awareness of the incident and that these factors influenced what information was used and how it was interpreted in the IMT.

Several participants spoke of the value of gathering some data prior to reaching the mine if they were not at site when the incident occurs. The value in this was to start processing and understanding the data, and even call others for advice, before arriving at the mine. This is a strategy many incident controllers employ [68] and one participant claimed that doing this has enabled him to arrive at the mine-site with more confidence.

Gaining situation awareness of the incident is difficult for the IC due to the IMT's isolation from the incident. The isolation means that the IC cannot use his/her physical senses to help diagnose the issue and is wholly reliant on information communicated by IMT members.

> *'The IMT still depends on people. They are only as good as the information they receive. And they are only as good as what they basically do with that.'*

> *'The information coming in is as strong as the team you've assigned to go and get that information for you. So if that info is not coming in an appropriate fashion to you, then again, change the team.'*

Some interviewees believed that due to this isolation the IMT cannot achieve full situation awareness, *'the IMT can be sitting in a nice comfy air conditioned room, so what's the situation-awareness there?'* Similarly, in response to the researcher asking how the IC acquires situation awareness, another participant replied *'I don't think he can, if you haven't been there you wouldn't have a clue at all. You can't. I don't think so.'*

Some participants believed it essential for the IC to leave the IMT to identify information that may not have reached the IMT meetings.

'You've really got to be there and you have to be involved in. You have to be able to see all the monitoring and everything yourself, you can't just sit in another room and pretend to be in charge.'

'There is times when there is an information gathering process going on as part of the IMT. So the IMT is basically disbanded doing some info gathering. The leader should take that opportunity to actually go to the control room and the monitoring station and basically interact with the people, especially in the early days, the people that are doing the debriefings, or their surface controllers, underground controllers and all the rest of it, just to get a feeling about whether they feel the situation is under control, whether they've heard something abnormal.'

In terms of what is acceptable within the MEMS structure, there seems some confusion as some participants stated explicitly that the IC should definitely not leave the IMT room, yet others thought the IC should. However, there was generally agreement that if the IC left the IMT room, the IC must not interfere with the functional groups because this would lead to micro-management, trust issues and confusion over authority.

Interviewees spoke of the difficulty of not being able to look, feel, hear, touch, and smell the environment to assess it.

'And there's another thing too, I work a lot on gut instinct. You know when you get the old gut-feeling that something's not right, generally it isn't. And that's what I've learnt in the mining industry. I can walk into a part of the mine and go whooa, something's not right here. Back up. And generally something's not right, the roof's or it's going to fall, it's just a gut-feeling and experience I suppose comes into it. I believe in gut instinct. But they can't use their senses in an IMT.'

However, an additional sense was stated by several to be required, a sense of the mine itself. Most believed decision-makers needed to *'know'* the mine. But simply knowing the mine, its layout and its operations does not fully articulate what the interviewees were describing.

'It's

the mine

almost like a coal mine is a living creature, it does things and over time you learn what it does and how it reacts especially around things like ventilation and gas management. So it's almost like a living animal and you've got to understand your mine.'

This participant believed that knowing the mine is essential, to the point that if an emergency occurs at a mine where the mine-manager is new, and unfamiliar with the mine, the mine-manager should relinquish leadership to someone who does know the mine. This indicates

a belief that the situation-awareness required in an incident is more than the technical facts available at the time; that decision-makers may rely on intuitive knowledge of the mine to inform decisions.

Notwithstanding that, the process of obtaining the data to guide the situation awareness commences immediately following the realisation that something out of the ordinary has occurred. The interviews confirmed that this is a time characterised by confusion because of a lack of information. The IC must request others to gather the data that will assist him/her to identify the current conditions underground. However, if the IC has a bias, either conscious or unconscious, this could bias the direction of this initial data search. If the IC only seeks data that is irrelevant or that confirms a bias, this can skew the IMT's situation awareness and subsequent decisions.

> *'Experience also frames the direction in which you look [for information]. So you start to make the situation fit the one that you dealt with successfully before. Em, so I suppose there's plusses and there's minuses.'*

It is also critical that the IC seeks the information that is missing but that could potentially determine the true situation.

> *'What do I need to know? What do I know? <u>What don't I know?</u>'* (emphasis added)

Further opportunities for bias occur when the IC receives information. At this point filtering the data was said to be a necessity because the information can come from almost anywhere,

> *'Like old mate over there could never have been underground in his life but he was standing there and 'Oh, I heard this, I heard that' so it's like squeaky wheels stuff'*

its accuracy is sometimes questionable,

> *'you are going to be fed a lot of information, some of which is shit, some of which is good stuff or not really relevant'*

and that

> *'People are very good at making information up. They invent it. It's not a conscious thing that they do it deliberately. They get a piece of information and they add to it and embellish it and then it gets passed on. And it's really quite strange and I've watched people do it.'*

Some interviewees implied that the information provided to them may be deliberately misleading, and that this filtering skill is needed to extract the truth.

'Some of the questions I asked, I know what the answer is and I can actually tease them to a particular outcome or in a particular direction, it's being able to go, 'I'm not actually sure you are telling me the truth'. It's about being able to, how's the best way to put it? Know when they are trying to pull the wool over your eyes.'

'Don't be aggressive but draw it out in a respectful manner. Probe. You can usually tell if you are listening to someone giving you some information back, you know yourself what is there. What he's missed, or if there is something more that you want to know.'

This ability to filter the data was perceived as a necessary skill of a good IC. Rarely was it considered that it could be a potentially misleading.

'Eh, I think experience comes into it in a big way. If you know what questions to ask, you can steer them. You've got the capability of steering it the right way or the wrong way and if you've got a basic understanding of what the situation is, and what the hazards are and you know what to ask then you are going to steer them down the right way.'

Interestingly, the participant quoted below, in a subsequent mine emergency exercise, seriously biased the IMT decision-making by working on a false diagnosis of the problem underground. He sub-consciously filtered out any information that did not fit with his interpretation of the situation yet his statement below clearly indicates that theoretically he knew of this bias.

'And you know what happens, the blinkers come on and then you convince yourself that you are right, and then when other information comes in, you manipulate it to fit your scenario. It's people taking information away and rationalising it away. Oh that's normal. Oh yeah and just dismiss it. And then the smallest, stupidist, little detail that fits that picture becomes important.'

The participants observed that decision-makers often sought excessive amounts of information prior to making decisions. Their evaluation of this behaviour was that the decision-maker was not confident of making the decision and was procrastinating.

'They [people who avoid making decisions] are easy to recognise because they are wanting, wanting, wanting more information, more information, more information, so there's a strategy of avoidance... this is very prevalent. There's only probably a handful of people who won't avoid making a decision.'

'It's your level of tolerance as to how much information you need to have the confidence to move forward, to move on. So it's somewhere between there, paralysis by analysis where you can't make a decision, to I need this decision to have integrity.'

A further point noted was that less assurance of the accuracy of situation-awareness is required when the decision is of low consequence. Similarly, when decisions are life and death, there must be absolute confidence that all relevant data has been sought and the situation has been interpreted correctly.

> *'It's about the right balance. Paralysis by analysis, or see what's my level of tolerance to make this decision and ensure it has integrity. If I lower my level of tolerance, I don't need as much information, or if I raise the bar, paralysis by analysis. This is where I need to raise that bar to if this decision is a life or death decision. Versus a lesser decision, where you go down the track and monitor and test your assumption.'*

Gathering information - Debriefing

Debriefing miner-workers who have exited the mine immediately before or after the suspected incident is critical because they may have seen, heard or smelt something that would assist the IMT. MEMS prescribes that a senior mining personnel should conduct debriefs to ensure the relevant technical details are captured and interviewees believed following a process would improve the timeliness and accuracy of debriefing.

However, one participant, from his own experience of being debriefed following a multiple fatality incident, indicated that following a process and a having technical understanding of the mine may still be insufficient to extract the most useful information from those being debriefed. What he discusses below are clearly non-technical issues.

> Participant:*'When people come out the mine in a real true incident, they know a shitload of information. They've seen it, they know, and you've got to tap into that, it's a real big problem.'*
>
> Researcher: *So who would you get to debrief them?*
>
> Participant: *'You've got to have someone that knows the mine. And who can emotionally divorce themselves from what they are being told. And not, you've told me something , Oh Jesus that's important, [and run off] and I didn't finish with you. So, yeah, you've got to have the right person, somebody the guys can talk to, will give the information to, but also somebody can take charge in the heat of battle, it's a bit like herding cats, the boys, everybody reacts differently and everybody has a story to tell and they want to tell you. And it's got to be one-on-one. You've really got to have the boys all held somewhere and take them one on one into a room.*
>
> *And I think when you are being interviewed there needs to be somebody there, because there are very few people who think, who can actually get the truth out of people. There was a really good guy, one of the [..], and I remember being interviewed by all these other people and getting angry and emotional and all the rest of it. I was*

up in front of this other guy for my final interview and he was just totally different. And everybody said the same, whatever it took to get the information out of people he got it. He'd probably been through something similar himself. I dunno, but he was brilliant. And all the guys said the same that he was a pleasure to talk to and he drew far more out of us than anybody else.

Big boys don't cry so that's how you are conditioned, you don't want to talk, you don't want to tell the truth, you don't want to open up because of the effect it will have on you.'

Gathering information - Validating data

Validating or *'challenging the data'* was identified as a critical step in the process of data gathering to ensure that accurate and complete data is used in the decision-making.

'We didn't validate enough. So I guess for me it's validate, validate, validate.'

Validating data that does not fit with expectations was a strategy encouraged by most of the interviewees.

'Don't dismiss data that doesn't quite fit the mould, don't dismiss that.'

'Yes, you should always be confident that if something doesn't ring true you should analyse. Is that true? Are we missing something?'

'Quite often you'll jump to a conclusion, and then other facts will come in and if they can be interpreted to support what your conclusion is then, you say, 'yip, they're valid'. If they don't, you can just say, 'well, that's probably not right, we can discount that, the eye witness must have been wrong, or there's something wrong with that fact.'

However, this is only half the story. Only checking the accuracy of data that does not match what is believed to be the case is insufficient. Not validating data that matches pre-conceived ideas is dangerous and contributes to confirmation bias. Interestingly, only one participant emphasised the need to focus on *'collecting that evidence that de-validates the decision.'* Surprisingly, one of the key criteria used to evaluate the validity of data was who provided the data.

'To challenge the info, has it been validated? Where did it come from? Who gave it to me? You know, know your people, know your mine, there's two parts to that.'

It was stated by several interviewees that if the person who provided the information was trusted, the data was valid and no further validity checks would be completed, unless the data was found to be potentially faulty at a later stage following the receipt of subsequent inconsistent data. In essence they allowed social influence, in the form of trusting others, as evidence of reality [153]. Conversely, information from an un-trusted source was scrutinised more thoroughly. This use of trust, a subjective and emotion based attitude, as a determinant of validity is completely contrary to the assertions that decision-making must be based on objective data. Therefore, trust issues could seriously bias the information used and ultimately the decisions made in a mining IMT.

> *'It's more about do I trust the person, he's given me the right information, I trust the person that he's done the check. That definitely affects my decision-making.'*

> *'I don't trust him so everything he said I analysed.'*

> *'In a lot of cases you've got to take that on face value. You don't have the time to drill down to the finest detail. And it comes back to that trust scenario. Trust, confidence, truth they're all linked.'*

Trust was seen as dichotomous, someone was either trusted or not, and this was established prior to the incident occurring. Generally, participants did not consider that someone may be trustworthy in normal situations but not trustworthy in the emergency environment. When participants were asked if they would trust the data even if the person was obviously emotionally upset, their responses stayed the same; if the person was trusted and the data looked okay to them it would be accepted without validation.

> *'I'd probably wait to see what the gas sample came out of. Being in the industry a long time you sort of get an idea of what to expect down there if there is a fire or explosion.'*

Only one participant recognised the deficiency in this:

> *'Someone who was, that you may have had trust, respect etc for, and they were credible. That might have been through peacetime operations, and then, they fall apart in a situation like this.'*

Another aspect of validation was the importance of not making assumptions. Interviewees spoke of false assumptions made in the past. These included assuming a roof fall occurred at Moura when it had been an explosion, and at a more recent event, assuming that drillers were reaching the depth required when they were not.

> *'Document your assumption, cause your assumption can bring you unstuck, you need to test the assumption. And often that step is missed out.'*

'I'm going to find that bit of data, to make your assumption incorrect. Now I may not find it but I need to go looking for it. Because once again, it's out there. The information to discredit the assumption is out there.'

However, despite the vehement calls for validation and to never make assumptions, several of the same participants were willing to make the biggest assumption of all: the survival time of miners. Four made matter-of-fact statements that, following a fire or explosion, if the miners do not self-escape in the first few hours they are dead.

'If they're not out in two and a half hours they're not coming out.'

Holding such beliefs may seem irrelevant in Queensland because the decision for rescuers to enter a mine is only based on the safety of potential rescuers and does not take into consideration of the survivability status of those underground. However, as events at Pike River highlight, the issue of survivability is extremely important for those working on the emergency operation and those who have family and friends underground. The impact of assuming that 'everyone is dead' or 'everyone is alive', is difficult to articulate, but one interviewee who attended Pike River stated that if anyone at the mine-site had openly said the men underground were all dead in the first two days *'they would've been lynched'*. Fundamentally, to assume the missing miners survivability status in any incident, without factual evidence, is to potentially be working with false situation awareness that could influence decisions.

Situation awareness of the incident - Understanding

For the information gathered to be useful the IMT must be able to interpret it and understand its significance. In this case too, attention must be directed at information that is not understood

'Most importantly identify those things you don't understand. Most importantly!'

Some interviewees spoke of the necessity of contacting experts for technical assistance because the IC may not be technically proficient in the problem area. This was where a reluctance to ask for help was said to become problematic, as it could potentially impact the IMT's understanding of the situation.

'I've got to be big enough to ask for help, I need to get the right people in the right place. I don't care where they come from.'

To improve understanding of the data in IMT meetings, one participant spoke of the importance of simplifying excessively technical data so that everyone can understand and maintain focus on the strategy. He explained,

'I can start to get intimate with 6 graphs. I can't get intimate with 21 graphs.'

Another participant suggested that all incoming information should be marked on a mine plan to help the IMT visualise the situation and think logically through what may have happened and what might happen next.

However, in addition to forming an understanding of the incident by working logically through the data, understanding was also drawn from reflecting on their previous experience or knowledge of previous incidents.

> *'I was looking at a series of mine plans I'm running all the information I got in the brief, I'm running through my head and I sort of said if there was an explosion that blew those blast doors off that fan, how could those two guys down that maingate survive? And [name] was there and he said they were blown off their feet. I said I've been in this industry a long time, I know what those blokes down Moura No. 4 told me that survived it, and the guys from Moura No. 2 told me, and they were a long way away from that explosion. And they were still blown over. You can't tell me those two guys would have survived.'*

Situation awareness of the incident - Prediction/Contingency planning

It is important the IMT considers how the situation underground may develop so that they can plan and prepare. In addition, they must be able to predict the outcome of enacting a decision. This ability to project is critical for an IMT to maintain control of the situation and is about knowing:

> *'what the mine is going to do. It's like when you make a vent change, you should know instinctively what the mine is going to do.'*

> *'If this changes what will happen there etc.'*

> *'I suppose foresight but that's as much technical as it is... It's trying to project forward as to, know what I mean?'*

Successful projection was said to involve visualising what may happen next and this is believed to be a skill that only some people have:

> *'They know what needs to happen, but they haven't got the ability to visualise how it's going to pan out... they can't visualise what's about to happen two steps down the process'*

> *'when you can't see something you've got to try and visualise what's happening and that's something I've found I can do very well.'*

Evidence that IMTs are projecting include the consideration of multiple strategies and putting in place a contingency plan or 'plan B'.

'you can brainstorm 20 different things that need to be done... and some of the things may be left field but they still need someone to go and look at it in case in two days' time or 12 hours' time, we need to do that thing. We need someone to have planned how to do it so that we can instantly say, 'Righto you guys have done an assessment of the ventilation system, tell us what the alternatives are".

However those who attended Pike River explained circumstances that prevented them preparing contingency plans, such as: being reprimanded by the police for discussing the survivability of the miners; being instructed not to organise mine inertisation equipment because of the message it would send to families (if a mine is inertised all life is extinguished); and the number of people in the IMT room, including external agencies and a large number of police officers, meaning that brainstorming and technical discussions could not be conducted openly. This reveals that it is not just the skills of those involved, but the environment in which they are working, that can impact upon projection and meaningful preparation.

Situation-awareness of the emergency management team and environment

The IC must simultaneously maintain awareness of the teams working on emergency operation whilst retaining awareness of the incident itself.

'I think that was his [the IC's] biggest strength, he was managing us more than he was managing the incident.'

This awareness of the emergency management operation as a whole was commonly termed the *'big picture'*. One participant explained some of the *'big picture'* roles he had when he was an IC:

'I've got to make sure I've got the media covered, I've got to make sure I've got the Government covered, I've got to make sure I've got the local community covered, I've got to make sure I've got the families of the people who are working here are covered, I've got to make sure my employers are covered, and I've got to make sure the rest of the employees of the company are covered.'

This situation awareness differs from forming an awareness of the incident itself because it is not a technical interpretation of facts. To monitor for potential conflicts or personal issues within the IMT, functional groups or even the mine workers and the response as a whole, there needs to be an understanding of the emergency environment. This includes an understanding of how people may react and this point was emphasised more by those with experience of multiple-fatality incidents than those without. It was suggested that the IC must escape the confines of the IMT room if he is to gather the information that will help him assess the success or otherwise of the emergency operation as a whole:

'you can't just sit in your glass bubble and hope to Christ it is. You've got to go out and monitor it to make sure that it is. ... In a matter of seconds you can establish if things are working or not.'

'I know in my experiences if I'm walking around the pit I'm always aware of what's going on around me. And in an IMT situation, you need to be aware of what's happening in logistics, planning and operations, and that's what I was saying, he needs to come out and touch base with everybody. Because when they meet with the IC it's only the lead person out of each of those areas and maybe the mines rescue bloke, but that's it, and does he really know who's in all these teams and he might want to go, I mean I know I would, if I got a spare moment I'd be going 'how's it going guys?' , I've got what you want to do and we're working to achieve that. Is there anything else you think I might need to know. And it might just trigger someone. [to pass on a bit of information].'

The skills the IC requires to monitor the teams, the stressors and the coordination have been neglected as requirements for a successful IC in the historical mining literature, including the Level 1 reports. These skills are difficult to define possibly because they are intuitive to some and difficult to articulate to others. Additionally, the illegitimacy of intuition and gut-feel in the mining decision-making process may mean that such issues are simply not recognised as decision-making. However, the interviewees recognised the need for these skills, the difficulty was in defining them. This is possibly because *'gut-feel'* would be a perfectly valid tool to use to establish this type of situation-awareness in complete contrast to the industry's rhetoric of objectivity and validation which is required for developing situation-awareness of the mine.

'And you need to know what you are looking for... And when you walk in the room, this looks right, feels right, smells right, tastes right. Or, shit what's wrong with this picture. And don't ask me to explain that!'

'It's just a gut thing. I can't, on an individual basis, go well he's short here, he's short there. It's just on a gut-feeling, and it's the mix, whether there's enough people with an understanding of the operations around him, know enough to be dangerous, whether that person can be both a listener and a communicator, em but also too if I see some staff around them what sort of body language, emotion, respect so what sort of conversations those people have. It's all people things, subjective things, feely, touchy. smelly things.'

One concrete indicator of the health of a response was rumours. Several participants spoke of the importance of listening out for, and quickly addressing any rumours before they cause trouble.

'Whether it be a hallway conversation or a meeting conversation, that is the indication of how healthy the organisation it.'

The overall category of situation-awareness, including situation-awareness of the incident and situation awareness of the emergency management operation reveals that the IC and the IMT need both technical and non-technical skills to maintain an awareness of the situation as a whole.

Coal mining is masculine, objective, it's a technical and tangible environment, it's about cutting coal, it's practical, it's big machines, it's getting dirty and it's about making lots of money. When an incident occurs, this environment changes to one where mates, emotions, wives and children are at the forefront of people's minds and the work-priority is about saving lives and jobs. It seems that an introduction to this emergency environment and how those who are required to work in it may react would assist the IC to maintain productive, collaborative and cooperative teams.

5.3.3 Collaboration and Cooperation

The MEMS promotes collaborative decision-making in the IMT with the IC responsible for decision approval. The advantages of collaboration are said to include greater adaptability, productivity and creativity [172] a view echoed by several participants.

'you need to involve the people around you, each one of them have got their own experience and skills and knowledge and understanding of the logistics of the layout of the mine and technical skills and you'll get a better outcome if you use the team approach to make decisions and not to try and be the know it all.'

'In a real one [incident] no one consciously going 'I'm in charge'. You become more of a collective. And somebody will say why don't we do that and everybody will say yeah that's a good idea and we'll go off and do it.'

However, establishing this collaboration may not be as simple as it sounds.

'There are a lot of dynamics in that team and depending on how well they mesh together, is how effective and efficient the IMT can be about decision-making.'

The collaboration and cooperation category in the taxonomy is essentially about teamwork issues, but because each IMT member is both a leader and a team-member, an incident command structure is applied and there are potentially many *'teams of teams'* (a term used in [174]), meaning that the term 'collaboration and cooperation' is more appropriate than teamwork.

Collaboration and Cooperation - Selecting the 'right' team

The IC's ability to form a good decision-making team by selecting people with the *'right'* skill-sets, personalities and relationships with others, was deemed critical. The assumptions driving this belief include that the IC has a working relationship with the team-members before the incident and knows their strengths and weaknesses; that trust, rapport and respect have been established;and that fundamentally, using a pre-selected and optimal team is physically possible. The IC may not know the team members well or the IC may be unable to access his *'first pick'* of team members for various practical reasons, such as someone is on leave or has been involved in the incident.

> *'So it's just a matter of picking the right technical skills and the right personality combined to do each of the roles. If you get the team right you'll get a reasonable outcome by and large.'*

> *'So, I guess a lot of it is, if you want success, it's not trying to pull it together at the time, it comes down to knowing the team that you assemble beforehand and knowing what drives them.'*

In addition, existing relationships may be poor, lacking in trust or prone to personality clashes that could exacerbate interpersonal or intergroup conflict during the emergency. In such cases participants have deliberately separated individuals whose relationship was known to be volatile.

> *'I've actually seen these two guys in a public forum how much they don't respect each other [name 2 and 3]. There was no way in the world I was going to let that relationship, or the emotion of that, affect our situation.'*

Deciding upon the *'right'* people for the team was perceived as an easy task, and was said to involve ensuring a balance between their technical and non-technical skills, their personalities, the type of situation (i.e. fatalities or not), and the skills left available for the backshift teams in protracted incidents.

> *'If someone is a bit aggressive you need someone that's a bit conciliatory with them to pull them back.'*

> *'If I'm the mine-manager and I've only got one VO, should I have him with me or should I leave him for the guy that takes me off, to lift the skills at that job? It's not just looking at who's the best person, it's looking at who you are going to put with people to cover their weaknesses.'*

A common belief was that implementing personality testing would help the IC form better teams. There was no appreciation of the theoretical and practical complexities and limitations of this.

The general strategy proposed by most participants was that the IC should construct a team based on people the IC knows. Only one participant was opposed to this concerned that the IC would chose to work with people he/she liked, trusted or generally agreed with.

> *'they maybe select the people they want to deal with, they know how they work and that worries me. I'd be quite happy to walk into a room of strangers as long as I knew their credentials or I could find out.'*

The same participant stated:

> *'I have no problem with disagreements in IMTs as long as they are resolved and there is an outcome.'*

Collaboration and Cooperation - Interpersonal conflict

In addition to being the result of disagreements, interpersonal conflict develops when someone feels they are not being treated with respect, when someone is not trusted, when someone is suspected of having an agenda (an ulterior self-serving motive), when decisions made are perceived as poor and when personalities clash.

> *'Where it [teamwork] will fall down is if two personalities clash badly where you can't communicate, you can't be bothered talking to that person because you think they are an idiot. So it will never work, it can't work, you need to be able to work together.'*

The tough masculine culture of the industry is not one that promotes conciliatory behaviour; *'it's that, 'righto I'll take you outside' business.'*

> *'if you get two strong personalities one will not want to seem submissive to the other. Giving in, in the mining industry unfortunately is a sign of weakness and submissiveness.'*

Interpersonal conflict within teams appears frequent and was noted as the source of much anger, frustration and withdrawal from IMT discussions. The extent of people's reaction to conflict during the interviews was indicative of how problematic this can become. Participants recalled occasions when interpersonal conflict had caused communication to break down completely, had resulted in team-members leaving the site completely and even becoming physical in and around an IMT.

> *'I can tolerate a fair bit of idiot, but it gets to a point where you can't tolerate it anymore and therefore you don't want to deal with them.'*

> *'One of the young engineers got jumped on fairly heavily by the guy that was running it at the time, and that was the last we saw of him for a couple of days. You know, 'screw you, I'll go and work on something else.'*

Open conflict results when the recipient of the perceived wrong-doing retaliates, and this seems common. People seem to personalise the other person's behaviour by taking offense and this can result in them reacting emotionally or retaliating physically. Participants believed this phenomena is exaggerated when existing relationships are poor and are magnified by fatigue and stress when people are naturally more likely to *'snap'* back. For example, one interviewee justified his personal retaliation by explaining:

> *'He was a little prick anyway.'*

Two participants suggested that personalities get stronger in the emergency environment and could therefore exacerbate interpersonal conflict:

> *'So if you are highly aggressive and you are under pressure you will act in an aggressive manner. If you are naturally an introvert, under pressure you will become even more introverted. Which isn't a good thing if you are a mine-manager.'*

Interpersonal conflict is obviously bad for harmonious teamwork, but of more concern is that it often resulted in a breakdown of communication potentially affecting the IMT's situation awareness and decision-making because information may not be passed on or decisions may not be challenged. Furthermore, even if communication does not cease completely, the persons involved in the conflict appear to waste valuable cognitive resources on unproductive thoughts rather than the team goals. For example:

> *'...and one bloke, I thought he was a bit of a dick, and some of the stuff coming out was just rubbish and I could see myself falling into the trap of just arguing with this bloke because he was, if he opened his mouth it was going to be bullshit, so I was going to show him how clever I was by proving how wrong he was. Fortunately I saw, I've had enough experience with screwing up before, that I could control that a bit.'*

> *'If they are not playing well with others in the team, it's difficult to focus on.. The decision-making is more combatting that bloke rather than... What if he gets one over on me or what if I say something wrong and he jumps on me, it becomes about me instead of the incident. So batten down the hatches against this guy, by putting up the defence, which is really not constructive at all. It's not useful for the process.'*

> *'And I can tell ya, towards the end I thought about just strangling this bloke [the IC] and putting him out of his misery. And, I just sat there with a smile on my face and thought you are the biggest wanker I've ever met and I could strangle you... but I had a smile on my face. It wasn't worrying me, it was just a thought that went through my head a couple of times.'*

'You can't let your own feelings and emotions override the situation, or the needs of the team or the situation, or the people you are looking for. And some people can do that and some people can't. And, if you allow that to happen that's what's occupying some of those units in your brain, those, 5, 6, 7 units or whatever they are, so yeah. And how do you train people to do that, just to say. I know heaps of people, I mean I think I can go, 'yeah, righto' and get on with life but there are some people that just can't.'

Personal conflict instigated by the IC was deemed particularly disruptive and that to avoid it, many believed the IC should not personalise issues. However, it was also noted that those on the receiving end of any negativity should not take the IC's behaviour personally and *'drop the bundle'.*

'You have to be able to deal with immense stress, and be able to stay reasonably calm throughout. Now there were a couple of times where I lost my shit, there's no question, but the guys, I never once personalised it, it was always about the transaction.'

'I've seen a mine-manager verbally abusing his VO because the VO didn't know what to do, he didn't know - yet the mine-manager wanted it, who was also the incident controller, and he just lost the plot and he was so emotional about abusing this guy that this guy just walked out. He was never ever going to get the information he was looking for.'

'Then it's probably for the IMT leader to say well, 'that's very good what you are saying but it's a load of crap, shut up, and let's listen to what this guy's saying.' And if the people in the room are trained that they don't get offended by that. You don't want someone in the room, that the big guy at the end of the table says, 'Ruth, that was idiotic what you said there', and doesn't contribute to the rest of the argument. But I don't want Ruth to shut-up until the end of the day. I want you to come back the next time when you've got an idea, and you will see that, some people only get slapped once and they go into their shell. So when you think about it that's something you could train.'

Collaboration and Cooperation - Inter-group and inter-agency issues

Conflict is not restricted to individuals. In an emergency scenario many groups are involved, these can be formal groupings such as those prescribed by the mining emergency management system and other agencies who are responding (such as the police and mines inspectorate), or informal-groupings such as those who were at the scene at the time and those who arrive later. The creation of factions between groups is again not conducive to good teamwork and has often resulted in communication failure.

This issue was frequently commented on by those who attended the Pike River mine. The conflicts included the police versus mining people, the NSW versus QLD mines rescue services, the IMT versus the workers carrying out the tasks and Australians versus New Zealanders. Interestingly, interviewees from both the QLD and NSW rescue services recalled the same event and gave almost identical accounts of the discussions surrounding the same decision, yet both felt that they were *'railroaded'*.

> *'There was a massive friction with the mines rescue, the families, the pit and the police. And it was like, I suppose, a lit fuse. That's what I felt, you know.'*

> *'I became a bit of a target, this bastard from Australia won't let us go in. I'd walk into the room, and a cold cloud would come over the room with the rest of the guys and I could feel it.'*

> *'they'd been totally ostracised from the IMT and they are sitting in their little world, and they're churning away, that's the enemy over there, they are telling the families and it's really cutting us up, they are all Aussies this management team, and they are our people down in the town, so there was this real hatred.'*

> *'There was a lot of vested interests, politics, you know the police were sitting in the corner, we had a committee like an expert panel who were just a faceless mob of people that we didn't know that were reviewing our stuff. So all the way along there was this management of sensitivities, personalities and making decisions.'*

The level of the conflict at Pike River was a surprise to some.

> *'I didn't expect that when I got there. I didn't expect that that was the case, and I worked it out pretty quick. And one of thing I felt was gee whiz, it's going to be a difficult thing to manage because you've got this split in an extremely stressful situation.'*

Interviewees identified that the biggest source of conflict at Pike River was the police taking the lead role and not seeking advice from the mining personnel located at the mine-site. Factions developed because the mining people felt they were not being listened to by the Police. This meant that mining groups did their own thing until they were instructed to stop by the Police. The delays to decision-making and some of the police behaviours caused severe frustration.

Despite the common goal of rescuing the missing men, the police also had a vested interest in preserving the crime scene and collecting evidence. Several of their behaviours associated with this irked the mining people whose sole focus was the rescue. One of the most disruptive police behaviours noted was removing evidence such as computers from the mine offices while the mining people were working on the technical aspects of a potential rescue. The large number of police in the IMTs and the fact the police sat down at the table during IMTs, while the

mining people stood, were interpreted as a display of power. Another spoke of the police having casual conversations as if it were just another day at the office, while for the mining people, this was perceived a disaster of a grand scale. These issues, amongst others, meant that the IMT meetings were avoided by some.

Pike River is not a lone case. Three participants spoke of the hostility they have received and observed during other incidents when they arrived to offer assistance.

> *'So it was a real bastard of a pissing contest in there. Which I thought was odd.'*

> *'The IMT was in a small room like this and I was invited in, and the usual suspicion when you walk in.'*

> *'So there was almost like the Hatfields and McCoys when you walked into the yard, you had to be careful who you spoke to because, which group you were associated with after that. It's quite a strange place to be.'*

Several participants spoke of how they tried to establish communication with those shutting them out by trying to win their trust, agreeing with them or spending time talking to them. However, in one case this was not successful and it was feared that if the in-comers were needed to assist, their assistance would not have been accepted.

> *'It was almost a closed shop there. We were... seen as the interlopers coming to save the day. Quite low key, but hard to get information, people just shut down and wouldn't give us the information, and wouldn't really be associated with us.'*

The perspective of those at the mine, who are reluctant to interact with the said *'interlopers'*, was explained by someone who had felt that way whilst recovering bodies.

> *'people are more than prepared to go back day after day. And people would actually be upset if they don't go back. Other people want to get involved but the people who are there won't let them get involved. It's quite bizarre.'No you're not going in there', it's you know. It was the same people and they will not suffer anyone else going. It's really strange.'*

Another participant who had also experienced body recovery over a period of days explained that although many people can arrive at a mine-site following a fatal incident,

> *'they are not affected the way the people who work at the mine are affected'.*

In addition to it being their own colleague's bodies that these men removed from the mine, and the obvious distress arising from that, it is possibly more emotional for them because it is their workplace and it could (or even *'should'*) have been them that was killed. It seems important to recognise the ownership that those who work at the mine will want to take.

However, group conflicts have also arisen between technical people from the same mine and should be working together. For instance between the MEMS groups and also between an IC and the staff at a mine, when the IC was a contractor and most of the employees were staff.

> *'When I've been involved in one particular fatality, people in the operations group were blaming people in the planning group, potentially for the incident happening in the first place.'*

Similarly, conflicts have arisen between the mine and the mines inspectorate. Both have a vested interest in keeping people safe, but the mines inspectorate do not face the same financial repercussions the mining company will if the mine is sealed. If the mines inspectorate adopts a policy of no risk, they could close a mine. However, a mining company will be more motivated to quantify the decision risks, rather than take an overly conservative approach, because closing a mine would have serious repercussions for shareholders and potentially hundreds of mine employees. It is the mine, not the mines inspectorate, that will have to live with the financial consequences of a closed mine.

> *'That incident created a lot of tension, and word came back to our rescue guys, 'Oh, they're [mine management and the mines inspector] not making any decisions in there now, it's all to-ing and fro-ing and who can get the upper hand on somebody.'*

The concerns raised here echo those highlighted in the mining industry report on trust which claimed 'The relationship between mining companies and inspectors, in particular, is fraught with sensitivities, and the opportunities for mistrust to arise are potent and plentiful' [82, p. 21].

Collaboration and Cooperation - Roles and responsibilities

There was general agreement that people need to focus on, and remain in, the roles that they have been assigned, even if it is the *'dunny monitor'*. The implementation of the MEMS, and training in this system, has to a degree addressed the issue of defining the roles and responsibilities:

> *'So the MEMS program is designed so that decisions are made at ICT, planning comes up with the plans, logistics gets all the bits and pieces that you need and the operations puts them into play.'*

However several participants implied that the implementation of an incident control system is insufficient on its own to ensure that each of the team members are clear on their roles and responsibilities. Roles and responsibilities in a mining emergency are dictated by the mine's own emergency management plan and duty-cards, which are only guided by the MEMS structure. Duty cards are distributed upon discovery of an incident and list the tasks associated with each role. However, duty-cards were often criticised for incorporating too much superfluous information:

'The duty-cards are like that [indicates an inch thick with his fingers] with all that information on them, fantastic information, but trying to transfer that information into your head when you can see gas alarms going off. Not a chance!'

'One exercise, I got half way down the page of my responsibilities and that's as far as I got. Alright, so those duty-cards we've got, they've got all this bull-shit on them.'

Another problem is actually understanding the duty-cards and the management plan in the stressful emergency environment:

'Someone will hand me a duty card and if it's not one I'm familiar with, I've gotta really struggle line by line to go through it.'

'I can't, I've been given things under stress before. Someone will give me a procedure, I can't read it. I physically can't read it. Even if it's in letters that high [about 5cm with fingers]. I either know it or I don't. If it's not in my head by that stage, it's [too late]'.

It was suggested that the following conversation should accompany the distribution of duty-cards:

'if I give you a duty card, I'd say 'Ruth there's your duty card, all the dot points of what you are going to do, please before you go anywhere please sit down, read them, understand them and tell me what they mean to you, because my expectation when you walk out of this room is that you are going to deliver to me everything that's on there. And if you can't deliver what's written there I need to know why.' Five minutes spent one-on-one with the respective card holder will make life so much easier as your day progresses. 'If you are not sure Ruth, you tell me what part you are iffy with and we will go through what it means'.'

It was seen as vitally important that everyone sticks to the tasks the duty-cards specify.

'don't jump in to someone else's role. Allow people to do the role that they've got. Each role has got a specific set of actions, and the duty-cards, it does set you off on the right path and you've got to follow it. And stick with it. Not jump around from role to role. And not try to do your reportee, not try do his role for him. All you can give is guidance if you pick the right person you are halfway there.'

The concept of clearly defining roles and responsibilities fits with the philosophy of making sure key taskwork is completed but does not facilitate collaboration or cooperation and is therefore not in-line with the social pre-requisites essential for successful implementation of an incident control system. The ICS is reliant on cooperation and collaboration, yet there is

no allowance for teamwork in the MEMS. The duty-card system not only tells people what they should be doing but indirectly tells them what not to do i.e. if it's not included on your duty card you don't do it. However, this unrealistically pre-supposes that the duty-cards have been written with such accuracy that all of the tasks required for each potential emergency management scenario are included.

Implementation of an ICS does not improve collaboration or cooperation and it seems that perhaps the implementation of this structure, for use only during emergency situations, can cause increased animosity. One example includes that of deputies who are statutory officials at a mine and report directly to the mine-manager on a daily basis, yet in MEMS they don't.

> *'You can't take that system out totally or take it away from them because then they don't know what to do. They are like fish out of water. 'Oh, what do I do now?' They take their statutory officials and sit them in a corner. It's fucking bullshit. And that's what happens, because they won't do it. They find their way around this. So they have their little meetings over here, and little meetings over there.'*

Collaboration and Cooperation - Maintain focus on the objectives

Participants identified that setting goals is crucial. Management by objectives is a key principle of MEMS therefore it is unsurprising this topic arose. Participants believed that setting goals and objectives was a good method of leadership because they helped to align the team and maintained their focus.

> *'And I guess can make the teamwork easier by defining what the objectives are. It's much easier for a team to work if they know what the goal is.'*

Of particular emphasis was the need to have clear goals at the early stages of the incident, when teams have been unsure about,

> *'what they were doing. What the focus was, where they were going, why they were doing, what they were doing, what needed to be done, what to focus on'*

as the situation develops,

> *'the goals and objectives may change rapidly due to new information being received'*

or when things start to go wrong,

> *'Now there could be a time when it all goes wrong, and that's still holding the discipline of that's what we're here for. What's the objective? Has the objective changed?'*

In particular, goals were said to need redefinition when the emergency changes from a rescue of live miners to a recovery of bodies. Participants explained that at this time, the objectives, the pace of the response, the way decision are made, and the priorities all change.

> *'it's now not a rescue, it's a recovery, and so then your thought processes change because the urgency comes off.'*

> *'the objective then moves from finding people to getting people out of the mine. And that part is much better because there is more information and more of an understanding of what's happening.'*

> *'One of the big things that I think is important in these situations is to determine when escape changes to rescue / recovery.'*

Some participants suggested that goals and objectives should be negotiated with the IMT for socialisation,

> *'the objectives may be something you want to negotiate with the team. So they feel they are part of, being influenced if you like, and feeling a part of that social process'*

and because people may interpret them differently:

> *'the same four or five words don't always mean the same thing to people so it's good to explore around the table, what do they understand in terms of the objective, and what am I going to do to achieve.'*

> *'So it's about articulating your objectives well and everyone agrees. It's about, unless everyone is aligned with the objective then people can be pulled by another string.'*

The setting of clear objectives was believed to help the team maintain team focus:

> *'it's really important to have objectives so that everyone in the room knows what we are trying to do and there are great other things we can be doing but this is where we are going.'*

> *'we all know we want to get them out. But you know some people have the airy fairy objective of 'the health and safety of all the coal mine workers' rather than 'the objective is to extract longwall crew from there to here', right that's clear.'*

This category has revealed the complexities of working in a team when the environment and the structure the team are working within are unfamiliar. People can be unsure about roles and responsibilities whilst working in an environment where stress and conflict seems commonplace. The two issues that seem to underlie many of the comments included in this section were the need to trust and respect others and to have an understanding of one's own and fellow teammates emotions and stress. The importance placed on these issues by the interviewees mean that these are discussed in the following two separate categories 'trusting others' and 'caring for others'.

5.3.4 Trusting Others

This issue was so prevalent in the interviews and often one of the first issues mentioned, unprompted, that this seems worthy of a separate category.

Trusting Others - Trusting and having confidence in others

Trust was often forefront in many participants definition of what makes an IMT good at decision-making. Of particular importance to participants was the need for the team to trust the IC,

> *'If the men don't have trust or faith in your abilities, then it's not going to happen. You know, there will be the backlash.'*

> *'So first of all, you've got trust in that bloke, because at the end of the day there's only one boss and the rest are followers.'*

and for the IC to trust the team, primarily to avoid micro-managing as discussed later.

> *'You've got to trust the VO will do the right thing. You've got to trust that the deputy and the men will do the right thing.'*

> *'The IC needs to trust, he cannot go in and micro-manage'*

It was suggested that trust between the team and the IC must be developed in day-to-day operations because there is no time to earn it when an incident occurs.

> *'Normally the leader of the [IMT] is also in a senior management position, and would have been involved in basically your appointment to that position, so actually you trust that person's capabilities. If that is not already there you're in deep shit.'*

In many cases, a lack of trust seems to have led to communication breakdown because the untrusted person is not listened to or the message itself has become lost because the listener focussed on the speaker's agenda and motives.

'Destroyed any credibility that he had. The men had no respect for him after that whatsoever. Including myself. We refused to take orders from him from that point on because he was obviously more worried about himself than the rest of the men.' 'So yeah, we didn't want anything to do with him after that.'

'Just the way he talked. You know how somebody can say exactly the same words and get it across very realistically and someone can say exactly the same words and the hairs on the back of your neck go up and you just think I just don't believe this guy.'

Consequently, building trust enables a more open flow of communication.

'To a degree, once you won someone's confidence they'd open up and tell you a few things, nothing too sensitive but. It was just trying to break that wall down first to have a chat with them.'

'Communication is just so important, communication out, communication in, you need to establish that high trust environment.'

The relationship between trust and decision-making seems reciprocal. Decision-making is more effective when there is trust in the team, yet one of the ways trust can be gained is through positive appraisal others' decisions.

'We knew that the people who were making the decisions were making the right decisions, so that gave us confidence in them.'

The transference of trust was also spoken of. One participant spoke of automatically trusting an expert who was trusted by people he trusted. Another thought the only way that people would trust him as a credible source was if a respected person had overtly handed control to him thus indicating that he could be trusted and another spoke of the strangeness of being the person that received this transferred trust from strangers because he was introduced to the them as someone to be trusted.

Two participants discussed the role of trust in life and death scenarios such as rescue teams re-entering the mine following an incident. One concluded that trust alone is an insufficient basis, the other was willing to place all his trust in an expert.

'I had my pit gear on and there was complete trust in that he wasn't going to blow me up. In that way yes. You'd struggle without trusting the people who were making that decision. As far as making decisions in an IMT I guess so. Em... Eh... yeah I'm struggling with that one because if decisions were going to be made I wouldn't want to take it on trust.'

'Em, I suppose because [name] is who [name] is. I knew, cause I'd quite often ask him, '[name], if I asked you to lead the crew underground would you go?' 'Yeah, no problems at all. If you want me to go I'll go with them right now.' So I tested him quite a bit on that as well, to make sure.'

Only one interviewee was concerned by the fact trust had arisen as a key non-technical issue for mining IMTs. This participant's sarcasm in the first quote below, almost perfectly replicates the point another participant legitimately expressed in the second quote below.

'So you've been the boss since October, we all agree with 'Bob' because we all like 'Bob', we trust him, he's never made a bad decision yet.'

'So you respect that person and the shit hits the fan and you go, 'Well, I like X, he's very knowledgeable in his work, he's a good problem solver so I'm going to trust him make those decisions.'... That's how I see it anyway.'

Trusting Others - Having an agenda

If a person was perceived to *'have an agenda'* they were suspected of having priorities that were self-serving rather than in-line with the objectives of the team. To have an agenda meant you would not be trusted.

'Agenda, that's you trying to get me to do something for your personal gain.'

'If you've got an agenda you're screwed'

The most frequent person accused of having an agenda was the IC. The participants believed that due to his legal responsibilities he would be highly motivated to make decisions that would potentially absolve him, such as destroying evidence, rather than make decisions that are focussed on the best interests of the miners. This was commonly termed, *'arse covering'*.

'in our current format the IC tends to fall to the mine-manager, the SSE, in that area of high management. And they are the same people that are more than likely, or shall we say, possibly, caused the incident in the first place or were responsible for the things, systems, procedures, processes that caused the incident to happen. So initially that person, his response, or his first instinct, is to protect his own arse. And you see it at every incident control team, that the controller is first and foremost protecting his arse, the company's interests, then he puts the incident itself. But he's never ever there as primarily and solely to control the incident alone. He's always got background or baggage or something else in the background influencing his decisions.'

'And that's something that's pretty unique for us in our industry as the person who is culpable is the person who's responsible.'

'Well you instantly know if you are the mine-manager and someone dies at your pit, it's your fault. It's the opposite to innocent until proven guilty. It's your fault. You prove that it wasn't your fault.'

Participants stated explicitly that they needed to establish that a person had no agenda before they could trust them or have confidence in the decisions they made. As with trust, agenda and respect were linked to maintaining open and honest communications:

'So with [the name of the man he respects], he can actually challenge me, I can challenge him, and I know that what he tells me will not have an agenda attached to it. I know that it's not political and I know that it's not self-serving. What it is, is a conversation about solving a problem. So I had a heap of respect for him about problem solving. I had a heap of respect for [name] about problem solving, and it wasn't about personal agenda.'

Five participants spoke of people with personal agendas distracting from the goals of an emergency management response,

'All these little agendas going on while I'm trying to work out the explosibility of the goaf.'

Some examples of the behaviours that gave them away include:

'Concealing information, or keeping, once I've got it keeping information... information is power. Once I've got information that's for me and me alone.'

'The questions they asked, the jobs they give people to do.' 'everyone in the room goes why? What's that got to do with anything? So straight away people are going, why? What's your intention? Why are you doing that? So you know straight away there is another agenda.'

Trusting Others - Respecting others

Most participants, but not all, spoke of the necessity to respect their team-mates, especially the IC.

'He's [the IC] got to have respect. There's no doubt he's, the boys, everybody at the mine has to respect him and needs to see him as the leader, cause if you're the leader and you've not got respect people are not going to follow you, especially when the shit hits the fan. So yeah, you've got to have respect.'

Respect for the IC was believed to improve collaborative decision-making because challenges are not perceived as threatening, people will put more effort in for an IC they respect and generally people are more likely to accept the decisions made by people who are respected:

'And to me what makes an IMT work well is that the IC has the respect of all the people in the room, he consults with everyone in the room before he makes a decision, so even though it's his decision it's a group decision.'

It was commonly suggested that having good social skills was important to gaining respect.

'I can't demand that you'll respect me. I've gotta earn it. So how do I earn respect? Speaking to you nicely, helping you solve problems, getting you to help me solve problems in our everyday work and being a general nice person. And then you'll go well he's a really nice bloke, and he's really knowledge about what he does and he helps me out, I've got a lot of respect for him. So you earn that respect. Trust is much the same.'

Much of the differentiation between trust, confidence, respect seems due to the different meanings people attribute to these words. Trust and respect were often spoken of as a pair.

'So I wanted to see how much they trusted and respected the SSE. And, So I asked them, 'Do you have confidence in what the SSE's doing?'

Some participants clarified that it is less important to respect the person as a whole but to respect their opinions, technical skills, ability, decisions, resourcefulness, technical competence and their integrity.

'if I didn't respect his technical ability that would be a huge problem.'

'I don't care if he's a wanker, in all respects, if he's an expert in gas interpretation I want his input.'

5.3.5 Caring for others

This category was borne out of the many comments made about needing to care for, or have a sensitivity to the needs of those in the IMT and also the mineworkers and the families of those who have been involved in a tragedy. To have compassion for and display empathy towards the people closely impacted by a tragedy was almost always believed to be the IC's responsibility.

Caring for others - Caring for the IMT

Many participants highlighted the need for the IC to care for the IMT members. This generally seemed driven by a desire to get the best out the team.

'Researcher: What other skills make a good IC?

Participant: So, they've certainly got to have good mining experience. They need to care, they need to be open to people's questioning and able to interpret the way people are feeling within the group.

Researcher: What do you mean by care?

Participant: Well they need to appear to give a damn about the way I am feeling at the moment.'

'Well if your care factor for people is zero, they are not going to work for you. So you do have to be compassionate I guess is the word you'd have to use. Well, you've definitely got to be empathetic. Empathy is important.'

'I care about you, I care about your decision, I care about your input. So it is about helping that team feel valued and that their contributions are being processed.'

Caring appears to be another aspect of leadership and teamwork that is inter-related with trust, respect and communication. Caring was generally interpreted as being a mix of empathy, humility, sympathy, compassion and having sensitivity to what other team members may need or be feeling. Behaviours associated with showing care included how the IC speaks to people, encouraging people to contribute to open communication, treating people as you would expect to be treated, and actively looking out for people who may be struggling emotionally.

'you still need to be an effective leader, you still need to win the trust and respect of people, and that is about caring about them.'

'You've got to have empathy for your people and understand where they are and not drive them into the ground.'

'Caring has to come out in your choice of words and in the tone of your voice. And eh, and that has to be genuine, because if it's not genuine people will read that.'

'I really think that that you know, understanding, having an awareness of people's emotional state, of their limitations of their experience, you know, there's a whole bundle there that you need to be able to sort of ...and people might say 'I don't have time for that shit', 'I don't have time to look out for you, you either fucking do it or you don't, simple as that' but, that is not reality I'm afraid. We need to have that, you know particularly at the higher level, you need to be able to manage it.'

'I think, I don't know if it's to care. But it's certainly to understand the feelings of the individuals. What I try to do is visualise myself in that particular position, whatever it may be, and then you might get an idea of what that individual is going through.'

However, apparently a certain *'degree of detachment'* is needed and there is a limit to the amount of caring that is optimal for an IMT. This was often believed to be when it began interfering with the functionality of the group.

'My caring, would stop in terms of an IMT if any of it interfered with the functionality.'

'I have seen an extreme example of that where they are all trying overly hard to look after each other and it's bullshit, going in the wrong directions.'

'Yeah look. I think you've got to be careful about, as long as the caring doesn't cloud your judgement. I think that everything I did was doing was about caring about people. I wanted people in there because I cared about the fact I wanted them to see what we were doing and get confidence that I wasn't going to put them in a position of retrenchment. I cared about my team. The amount of times I said to my assistant can you go and get everyone down because we are actually eating in again so she'd go and get Italian or whatever. The fact that I was really thankful about how much effort they'd put in and all of that. So I believe all of that to be true but there's not one time when I let any of that cloud my judgement . If I thought somebody was not up to their job or they were too stressed to do it, 'you're off site."

The IMT members are the work colleagues and potentially close friends or family of those who may be injured or killed in an incident. Care and compassion in the IMT may be needed due to IMT members relationships with those involved.

'I mean no-one wants to lose anyone at a mine site and there's a fair chance you will know the people well, especially if you've worked with them a long time.'

'A lot of us have relatives in the mines and you might have to say at that point if he's got a son down there or a brother or someone, it might be best to remove him from there to get rid of that emotive side from it, because his decision-making is going to be clouded if he does have a relative involved.'

Four participants spoke of losing their best mate in mining accidents. Two of them were managers at the time and therefore key decision-makers during the emergency management operation. However, despite this, they all played an active role in physically recovering their mate's body from the mine. In all but one case, their mate was one of several fatalities.

It cannot be guaranteed that IMT members will not be exposed to particularly emotional stimuli and that this must be considered in mine emergency planning. Offering care and compassion may prolong their ability to contribute meaningfully to the response while also potentially helping them cope. The horror of some of the situations the interviewees have experienced cannot be underplayed and it cannot be assumed that the IMT members will not be involved. A real incident does not distinguish between IMT members and mineworkers, simply who is underground at the time. Two incidents were discussed where would-be IMT members were killed, one was the mine-manager, the other the under-manager.

Another type of care includes the team's physical and logistical needs. Managing an incident can take several days or even weeks or month. This means that IMT members may be living away from home, or be reluctant to go home, for extended periods of time. Some participants spoke of the physical needs that develop after an extended period of time away from home including the need for clean underwear, soap, razors, appropriate clothing, cigarettes, a homely environment, a comfortable bed, toothpaste, a clean room, everyday food (i.e. not too rich) and a need to take time out to be with family.

> *'if you're out at a minesite and fighting a mine fire and your bed's shit and the food's crap, you can't find your last pair of socks, you've got no more jocks left because you've been in the pit for 4 days, it just doesn't work!'*

Caring for others - Compassion for those close to the incident - Mine workers

Survivors of a serious incident may have witnessed emotional stimuli or may play a part in the rescue or body recovery. There is a practical and moral need to care about these team members' emotional state because these are the people that supply the IMT with information and action their decisions in the immediate aftermath of an incident and they will no-doubt turn up day-after-day at the mine if there is a protracted rescue or body-recovery operation underway.

One participant who was a manager, and in the mine at the time of an incident, revealed several issues that the IMT must consider when dealing with people who are physically working at the incident site. He explains that because these men are actively focussed on the rescue or recovery of their mates, passing information up to the IMT can be forgotten about. This, and the general isolation of the IMT means that the IMT quickly becomes divorced from the reality of the situation and the decisions they make can be seen as completely inappropriate, or even offensive, by those underground.

> *'this is where you get a massive disconnect between the people upstairs, who haven't seen it, haven't lived it and sometimes the messages that come down send the people underground absolutely berserk.'*

> *'people underground went absolutely mad because they are in the thick of it and these people are divorced from it [the IMT] and there was this massive disconnect. And I tell you we had people underground that wanted to go upstairs and punch their lights out. This caused a massive upset for quite a while until everyone calmed down.'*

The IMT must consider the emotional needs and cognitive limitations of those workers and how best to communicate with them to minimise further emotional turmoil whilst work is being undertaken. This possibly includes modifying communication strategies and the physical requirements placed on them. Examples of poor IMT decisions that have caused conflict between

the IMT and those working on body recoveries include: the provision of transparent body bags; disagreements about the appropriateness of recovering the personal effects from the deceased to give to their wives; insensitivity in the use of certain words; making inappropriate comments; and in one case making a poor technical decision, that would normally have been caught by the underground workers but, due to their reduced cognitive capacity, they simply did as they were told with potentially catastrophic consequences.

The IMT must also ensure the support required for those who have been involved underground is available. The mining literature suggests that people who survive an incident in the mine will undoubtedly try to help their mates [113] and this can involve extreme physical and emotional exertion. Two participants spoke of men physically collapsing shortly after helping with a body recovery and others going into shock. A similar situation arose at Pike River: it was only luck that the man who managed to drag his colleague out of the mine had sufficient strength to call the control room when he exited the mine before collapsing. No-one met them at the portal despite having the knowledge that they were exiting the mine.

A belief that mines rescue will always be the ones facilitating a rescue or recovery, and that they are somehow more resilient, is unrealistic.

> *'they [the industry in general] just assume we [mine rescue] are immune to the emotional side of things.'*

The assumption that sending those who are emotional off-site to rest will help them was exposed by the interviewees as being too simplistic and untrue. Several participants stated that going home and being alone were the worst times for them emotionally and that sleep and rest were not achieved prior their next shift anyway. This was true of both hands-on team members and IMT members. Four participants explained that coming back day after day to assist with a long-term body recovery operation was to some extent 'therapy'. They were not alone in believing this and felt it gave them a purpose at this time. The mining literature has highlighted the potential benefits of critical incident stress debriefing to assist people to continue to function [110, 109], but most commonly the interviewees explained the best way to cope was to spend time with mates that have been through similar situations, even if they just talk *'shit'*.

Long-term effects are not the focus of this research, however potentially the IMT can influence these effects. Some participants outlined their own ongoing emotional struggles including recurring nightmares. Seven interviewees became tearful during the interviews, others reported physical reactions such as getting goosebumps and another reported seeing his dead colleague's face s he was talking. Experiencing a mine tragedy was described as a life changing event. They spoke of many colleagues leaving the industry following major incidents and the psychological impacts on their lives including several cases of post-traumatic stress disorder, divorce and alcoholism. Any actions that an IMT can take to minimise these long-term consequences, such as allowing people to return to site and perform less critical tasks, should be considered.

'Well there's probably various tactics, and one is to, and I don't know if it's wrong or right, I think if you keep people focused , that might be another word for overloading, but if people are generally occupied there is probably less time and opportunity for stress levels to fester, build up and get out of hand.'

Compassion for those close to the incident - Families

Several participants believed that the IC has a responsibility to care for the families of those who are missing, killed or injured.

'He has to care about what he's doing and about the people that are affected. And as we talked about today there is a bit more than that there's a bloke trapped under there, what about his wife, what about his kids, all those things have to be thought about and he has to understand all of that and I don't think a lot of them [ICs] do.'

Although no participant explicitly stated that caring for the families directly impacts decision-making, it was a topic many raised unprompted. The need to care for them was assumed by most to be a role of the IC. Following a fatal incident families become important stakeholders and interaction with them becomes likely.

'Participant: Well if you've got to talk to a lady with a nine month old baby in her arms and her husband might not be coming home, doesn't matter how well trained you are, it might have been the environment that caused the issue, you know you've gotta, even though you are responsible for it you've still got to have that compassionate side, know what I mean? The buck stops with the mine-manager. I think that's important.

Researcher: Who says you've still got to care about that woman with the nine month old baby?

Participant: I would have thought that's innate in everybody. I would've thought. Gee, you'd have to be a bloody cold blooded bastard not to. But I don't know if there's anyone out there like that.'

Dealing with the families of the deceased was said by all who had experienced it to be extremely difficult, attending funerals was considered particularly difficult. One participant with emergency services experience said that he has found interacting with the families a lot more difficult than dealing with bodies.

Only one participant with experience at a number of fatal incidents spoke of deliberately not interacting with the families. He focussed on making sure the families were cared for in practical ways such as the provision of flights, accommodation or money and explains his reasons for not showing his personal concern below:

'In all of these things I always remove myself from the affected party. So I've been to three fatalities now, and there was funerals and wives and all that sort of stuff. So what I try and do is go, no, very sterile, very much this is what I'm going to focus on. But I stay out of that completely. Because I'm as human as the next person, I divorce myself from it until it's done. And then I'm happy to do what I need to do [to care from them].'

5.3.6 Personal strengths and limitations

This category addresses the need for those involved in managing an emergency to understand their own personal limitations regarding technical and non-technical abilities. In a team environment such as an IMT, this involves realistically appraising one's own ability to undertake the job at hand and an evaluation of whether continued personal input is in the best interests of the team. The importance of this ability was recognised by many participants:

'I think one of the most important factors for that person is to understand his own capabilities.'

'I think if people are smart they will ask for the right assistance. They will know what their own personal gaps are.'

'Have a good understanding of your emotions at the time and how is that affecting your decision-making. Be open and honest with yourself. Are you capable of performing that role and if not, be man enough or woman enough to say I can't do it emotionally and put someone in that can. And that's a big decision... I'd respect somebody tremendously for doing that.'

The physical and emotional stressors impacting IMT members were perceived to push some team members to their limits. This category considers a person's ability to recognise and withstand the stressors they may encounter during the management of a mine-emergency including social stressors, physiological stressors and psychological stressors. Social stressors include the emergency environment, the additional agencies this involves and how people are reacting to others within it. Physiological stressors include how people are physically and cognitively affected by the fight or flight stress reaction and long working hours. Psychological stressors include the possibly unfamiliar, confusing and potentially debilitating emotions that may be experienced.

Those who had been an IC noted that it would be helpful if others would recognise their own limits and speak-up when they were approaching their personal limits to prevent mistakes and poor decision-making. One IC stated that this would have helped him plan rest periods for team members during a response rather than relying solely on his own evaluation of their fatigue and stress levels.

'I think you need to be man enough to say, 'listen, I'm really fatigued, I need someone to relieve me.' And that's something people don't realise.'

'It would be good if we could get to the point where people put up their hand and say look I'm under stress.'

'[name] came to me and said, 'Mate, I need a break' and I already knew that he needed a break but when he actually said that it actually brought it all forward probably 3 or 4 days and I said, 'Mate, off you go.' So some people I've probably misjudged but it was a good enough relationship with the guys that I can tell, or they could tell me what they had to tell me and nobody felt that they had to be heroes in all of this.'

However, the macho and unforgiving nature of the industry seems a likely reason why admitting that fatigue, emotion or stress is affecting one's performance is not a common occurrence.

'I'm not tired I can push through to the end. It's a macho thing and it cuts across to the arguments. Once it starts it's very, very difficult to repair in our industry.'

'And the other thing is I guess once you've been broken by a lot of stress, the mining industry isn't very forgiving. Once you've stuffed up it doesn't tend to give you a second chance. You do tend to be tarred by the brush.'

'I cannot admit that I've lost control. I am a first class mine-manager. He'd rather let it fall to bits than ask for help. That was a major flaw. I've got to be big enough to ask for help, I need to get the right people in the right place. I don't care where they come from.'

'Like if I work dog watch and am exhausted, and then they say, 'well someone hasn't turned up, we need you to work day work as well' Sigh, 'oh, no way, I can't' but you're expected to be able to man up and be able to do that because that's what we do.'

Due to others' reluctance to speak out when they are struggling with stress, emotion or fatigue an ability to recognise and deal with others who are reaching their limits was deemed a necessary skill for the IC and team-members.

As an industry, failure to recognise and plan for the reactions and limitations of the people involved in the response is to omit a major component of the overall emergency management planning process. Currently, the prevalent view is that people will function in the roles they have been given, and those that are seen to be affected by stressors should simply be removed. However, it was noted by some that can result in the loss of vital technical skills.

The interviews revealed many aspects of the mine emergency environment that has resulted in IMT members having to deal with stress and emotion. It seems important to understand what it is that can drive people to their limits when responding to a mine emergency to potentially address these issues in the future. Emotion and stress are discussed separately, not because they are distinct, but to better reflect the terminology used by the participants.

IMT members becoming emotional is a reality. One participant spoke of a mine-manager who had to relinquish his role as IC due to shock, having been underground and seen the incident occur. Other participants reported seeing people *'turn to water'* or otherwise become incapacitated due to their reaction to the situation.

> *'Certainly I've seen people that have been affected [by emotion] because they know someone that's involved in the scenario, so I suppose that's got to be emotion there. And the symptoms there were very similar to that of high stress. He lost the ability to make effective decisions.'*

> *'Outside his normal character of, he was a good organiser but he wouldn't have been able to organise himself a pie for dinner that night.'*

> *'I haven't got any problem with people being emotionally connected with the people they are trying to save as long as they don't let it get in the way of decision-making. You'd be a pretty callous bastard if you didn't give a hoot about the people underground, but by the same token you've got to remain logical.'*

> *'My gut-feel would be that it [emotion] has the potential to, to impact decisions, and depending on the circumstances, if there were people killed, then it might happen, then yeah, it could really over-rule logical thinking.'*

> *'Oh [name] he was just a blithering mess. He was just hopeless. But there could have been baggage there.'*

The last comment highlights another aspect of emotion that an emergency can trigger that has appeared in the psychological literature [181]. Participants spoke of the risk of latent emotion, from a previous fatal incident, potentially biasing decisions in the future.

> *'Especially people who have had direct involvement, these things scar them for the rest of their life. And what that biases or does to future decisions they make. Sometimes experience can be good, but sometimes the decisions from experience are improved. But I wonder if sometimes after having been involved the next time, you either don't want to make a decision or I need to make a decision faster, what impact that would have.'*

'Even if you look at Moura No.2 , there'd be a lot of rescue guys, especially if they had involvement at Moura, that would be saying, 'there is no way we are going to leave guys in a mine again.' So that would have an impact on the decisions and what they'd do.'

People who are carrying a wound, from a major failure or a major emotional, I'm talking about an emotional wound, will start to operate through that wound, if its anything related to their working environment or past working environment'.

The following statement is potentially an example of this:

'Cause I'd rather be dead than have to live with the fact I could've got them, but I didn't. Because if I don't go in I've got to live with the fact I've just committed them to death.'

The extent of the emotion and stress felt during an IMT was clearly linked to whether or not there were people harmed in the incident.

'I initially thought we could have lost about 30 people, in the first 2 to 3 hours I didn't know if we had any fatalities or not. I mean we thought we were right but until we got everyone out and on the surface. That's when I aged about 10 years.'

'[Once] we knew there was nobody involved, there wasn't a fatality, to me the pressure came off straight away. I thought I really don't care, it's just a recovery of the mine.'

Yet, even when lives are not at risk there is still an aspect of stress because:

'I've also got the livelihood of all of these people on my shoulders I said and I don't know what decision to make.'

The difference in the stress and emotion when people are or are not involved was explained by some:

'they are both time critical, both potentially dynamic and can happen quickly, but the stress of this one is 'shit I might lose my job, or we are not going to meet budget' or this one where it's 'oh shit, the world media is going to be here in 10 minutes and I've got families on the doorstep and I've got blokes that I know down the pit and are possibly dead,' The emotional state is totally different in that one and the stress is horrendous. Or the potential stress.'

'If there were people underground, of course there would have been stress. Because there's that impact. Because the one thing we know in underground is that if there's any gaseous event, explosion or whatnot and somebody is underground,

you're dead. Right. It's only a miracle if you survive... So now my mate's dead and I'm out of a job, and I have to deal with all of that right now. So I think that the stresses are completely different.'

'The real stress there was the lack of communications with the people underground, and that people had to self-escape out of the panel and some nearly didn't make it.'

'There's obviously good stress and bad stress, there's the stress where it overcomes you the reality of the situation where I'm potentially responsible for the loss of a life or many lives or even loss of the asset. Even the 'I'm about to lose a billion dollar asset'. 'Maybe I'll just take that chance, I might get those guys to go over to that borehole, maybe I'll get them to go near the fan shaft when they should be nowhere near it, you know what I mean?' You might, that should be sorted out in the processes, the risk management processes and the checks and balances, but, I think it can cause you to make poor decisions or shut down all together.'

'It's a different stress. Look the people. It's a different stress for me. What it came down to. Everyone talks about it, but no-one gets trained in it. I get trained in heatings and technical shit, but they haven't trained me in all this other stuff. You know. And that's the bit that I guess I lacked. And I freely admitted it.'

Most interviewees were concerned that emotional people would make irrational and subjective decisions in an IMT and that, therefore, they should be removed.

'They are gone. They are out. It's just black and white. Em, as soon as someone starts to twitch they're gone. The trick is to recognise if you are twitching'.

'So, you've got to remove that person. Then you've got the task to get him, 'look that's very upsetting, we've got to be professional here and get the focus back, get back on track and solve the problem. So that's what I would do, remove the person and I wouldn't let them back in unless they had changed their frame of mind.'

Only one participant spoke of trying to work with someone affected by stress or emotion to extract whatever work they could from them.

'If I could get half-an-hours good value out of you, and it is good value, then I want it. But if that's your limitation, I've got to know that I can't expect you to work for two hours.'

Generally, emotion was viewed as the antithesis of being objective and professional.

'As soon as I walked into that IMT I forgot about [the emotional issue] The professional side kicks in and you've got to divorce yourself from that. And you can't let that cloud your decision-making. I'd like to think I was professional about it and I just didn't give it another thought.'

'You've gotta put, you've gotta try to put the emotional side of it aside and concentrate on the professional.... you need to be as professional as you can possibly be, and there will be time for the emotional things afterwards.'

'Eh, yeah. [name], we had to ask him to go. That's the last thing you want when you try to be objective is the..., bring emotion into the..., something I guess that needs a technical solution.'

Further, it was implicit in many interviews that to be emotional was to be weak. However, those with multiple fatality experience expressed more compassion and towards others than those without such experience.

Recognising and dealing with emotion and stressors - environmental stressors

This element is about understanding the external stressors that exist in an emergency environment and how they can impact decision-making. Pressures exist that are not prominent in daily operations such as: pressure from the families of those involved in the incident; the media; police; political interest; dealing with external agencies on-site; the knowledge that colleagues and perhaps family are in imminent danger; and generally working in an emotionally unfamiliar environment where people may not be behaving in their normal manner. The combination of time pressure and the severity of the consequences of many of the decisions makes decision-making in this environment particularly difficult.

'I felt the competing for time. People wanted an answer. And I felt that I was at risk of making a decision that potentially wasn't the right decision... So I felt the pressure. But I knew what it would look like and how important this decision was.'

Real and perceived pressure from the families was believed to have the potential to impact decisions due to a desire to appease the families.

'the pressure of even knowing the families were outside, and people wanting to interview us about what the hell we were doing, and just hearing them chat when we were out having dinner.'

The IC in particular was thought likely to feel tremendous pressure within the MEMS. If a mining company does not have public liaison staff, it is the IC who briefs the families and,

'It's a double edged sword for the IC because not only might he have to potentially go and speak to the families... but he's probably had something to do with causing the incident in the first place. In his mind, he would think that they know that. So that's certainly going to mean some emotional stress for him.'

There was concern that people may make decisions in reaction to the media to get *'good press'*. Accounts of the media pressure directly applied to rescue workers at Pike River and indirectly by the constant media coverage were considered highly stressful:

'how he handled that, phew, I'll never know. It was quite incredible the pressure and stress he was under. He came down in the street at one point and every second person wanted to talk to him, the media calling him.'

'very few people have been exposed to the onslaught of media. And it's relentless and so easy to say something that comes back on you like a tonne of bricks, you know that's not what you said or it's out of context or...'

Advice offered for the future included:

'Don't listen to the TV, don't listen to all the politicians making all those stupid promises',

a view echoed by a third:

'Try and avoid reading the media, not only reading but exposure to the media, and that's outside of the IMT. So your time when you are not in the IMT, try and avoid it at all times.'

Another environmental stressor seems to result from the historically tough, macho and masculine mining culture, and how individuals believe they are expected to behave.

'You've got to remember, 40 years ago the meat wagon came every day. Every day we were sending some poor bastard off in a meat wagon. And we were tough coal miners, you know, you get hurt in this industry, that's why we were paid so good.'

'It is, mining used to be... when I started in the mines a very aggressive culture.'

One participant who was struggling to explain why some IC's were better than others at Pike River, resorted to gender as a descriptor, highlighting that these cultural norms are retained in the emergency environment.

'Some of them were just more blokey. That's the wrong word to use because there were some lady police officers that fitted in very well and did a great job. Just maybe more..., you've been to the mines you know what I mean.'

To have this familiar *'blokey'* working environment change to one where men are struggling not to cry and are fighting real or perceived external pressures within a strong cultural norm to behave in a manly fashion, will likely add to the stress by being an unfamiliar working environment.

> *'And then when you go back on the job, and it's bizarre. You could see people were upset and you could see tears in people's eyes and look I've got no doubt people could see that in me but when you've got those same people back on the job, 'right, what are we doing?', totally different. Expressionless faces, quite blank faces but you could see in their eyes that they were alert. It's hard to explain.'*

> *'He said you know, 'hello' and welcome and we said, 'hello, how are you going?' and he just, that was it, he just really had to hold himself together. 'not good, not good'. And that just makes you think, look this is real, it's horrible.'*

Several participants explained that a need to preserve their masculinity had dictated the likelihood of them, and others, admitting to personal limitations:

> *'males are pre-conditioned from, you know. I've said it to my son, 'Big boys don't cry mate, pull yourself together mate', you know for a grazed knee. And we are conditioned right the way through so... you don't want to open up or show any emotion, you don't talk about it'*

> *'you're expected to be able to man up and be able to do that because that's what we do.'*

The term *'macho'* was used to explain the pressure some interviewees felt to over-ride their personal limits during emergency operations,

> *'I'm not tired I can push through to the end. It's a macho thing and it cuts across to the arguments.'*

Similarly, admitting to becoming stressed is not a characteristic supported by culture:

> *'Oh, I'm stressed', 'well you are as weak as piss, aren't you'. It's not the right word. Stress is what a housewife gets when the kids are playing up. That's the archetypal stress. It's not a manly thing.'*

One participant explained that once you succumb to stress you become *'damaged goods'*, it also seems that there may be career repercussions for *'stuffing-up'* in this way, only adding to the stress.

> *'once you've been broken by a lot of stress... the mining industry isn't very forgiving. Once you've stuffed-up it doesn't tend to give you a second chance. You do tend to be tarred by the brush'* (emphasis added)

There was a sense amongst the interviewees that some mine-managers don't believe that an incident could happen at their mine, and if it does, that they should be able to control the event themselves. This may account for the frequent delay in calling for assistance, both in the Level 1 exercises and in real events.

> *'it's certainly something I've got, and I think it's a bloke thing, 'it won't happen to me.'*

> *'there's a sense of 'geez, if I call [mines] rescue it's a blight on my, you know I've lost control, it's saying I'm not in control and I need help from these guys. Now I've got mines rescue here and it's on the 6 o'clock news.'*

Interestingly two of the participants who had a long history working in the fire service noted cultural differences between emergency management operations conducted by mining personnel and those by the fire service.

> *'The mining industry is very interesting because we are dealing with some very sensitive egos more so than in civilian authorities and I've been very fortunate to see both.'*

> *'Yeah. And it's always very difficult for people to take criticism. But you don't tend to see that in the fire service strangely enough. If we are doing a job in the fire service you can swear at someone, you can do whatever you need to do, but as soon as the job's finished there tends to be a switch off to a certain extent. Not that people are rude, but there's certainly a disconnect there.'*

The interviews revealed four distinct emotional stages in multiple fatality responses: The initial stage; the rescue stage; body recovery; and the post-recovery stage. This initial stage, immediately following recognition that an incident has occurred, is characterised by confusion, feelings of helplessness, panic or denial.

> *'that first half an hour to an hour you feel helpless you don't really know where to start and what to do.'*

> *'when we got there these people who were making the decisions, they were running around like chooks with their heads cut off.'*

> *'people were just wandering looking, wondering what the hell to do next watching the smoke coming out of the tunnel.'*

Secondly, there is the rescue stage where rapid decision-making is required amidst the optimism and hope of rescuing the missing miners. One participant explained this as being in

'suspense' at Pike River. Thirdly, is the realisation that the missing miners are dead, and, if conditions allow, the commencement of body recovery.

The following account details the atmosphere at Pike River when the mines rescue teams were told of the second explosion. This was the point of realisation, that there was no hope of survivors.

> *'Well, the outpouring of emotion. And it was the noise. I'll never forget the noise. Sort of that collective groan. And it was a groan, it was a sigh, it was... you know. Some guys went just dead... deadly quiet, and another couple of blokes just said,' thank you so much, that we are not in there,' and things like that and, 'now we understand why all this has gone on'. It was a very emotional period of time.'*

In mining IMTs this time has been characterised by feeling deflated and a loss of morale

> *'you could see everybody's shoulders sort of dropped.'*

> *'when you get to the point of knowing where the missing people are you feel really sad and you are really despondent about it but at least there is then sort of, the actions are then, the objective then moves from finding people to getting people out of the mine.'*

Fourthly, there is the post-recovery stage when any legal proceeding will occur and this can run concurrently with the emergency management operation inflicting additional stressors such as people starting to *'lawyer-up'*. This stage can potentially take years to conclude and several participants spoke of the ongoing stress they experienced associated with that.

When people are killed at a mine, they are colleagues and often close friends, family or neighbours. The distinction between work, family, friends and community is no longer real. The mine becomes part of all of them. For example, at Pike River, one man was observed pointing to his son's photographic ID tag that was hanging on the tag-board and heard saying *'meet my son'*. His son was, and still is, in the mine. Four interviewees spoke of recovering their best mate's body from a mine. One spoke of the survivor's guilt he felt and the heartache dealing with his friend's wife and children.

> *'people feel guilty. When you go to the funeral and you see the wife of the bereaved and the kids, and they look at you, and there's this girl, the wife, and the children and they are just totally in shock.'*

He explained that he and his fellow surviving colleagues perceived his friend's wife to be saying, *'why are you still alive and my husband is dead?'* even though it was *'Totally not true. There was just a young girl, just totally, you know.'*

Others spoke of the agony of attending multiple funerals.

'No Ruth, you don't want to hear this. I had to attend [number] funerals. I mean not only that, you don't only go to the funeral, you go and see the people the day before the time, and you meet them and you sort of, yeah.'

Another interviewee spoke of a fight breaking out between a mines rescue person and a local in the midst of a protracted body recovery mission.

'And the townspeople in [place] were calling us cowards for not going down and getting them out. See they didn't understand what was actually happening down there... Someone called him a coward and he took offence to that and it just went from there.'

And, another interviewee told of the following incident upon returning home from a fatal incident

'[I]went home, still had blood on my shirt, I walked in the door, and my son who would have been four or five, he blurted out 'what happened to the dead man dad?', that nearly destroyed me.'

There seems few places to escape the reality of a serious coal mining emergency situation and for those impacted the most, being alone is no solace. Being alone was considered the hardest time, and perhaps contributes to the historical reluctance people have had to leaving site during an emergency response. Some compassion around this issue is required.

These emotional aspects of the emergency environment are all relevant to the effectiveness of incident management at a mine because they potentially occur concurrently with the management of the incident. It was the issues described above that most frequently caused the interviewees to become emotional in the interviews highlighting the intensity of the emotion that they must still have.

Recognising and dealing with one's own emotion and stress

When initially asked about emotion, most interviewees spoke about interpersonal or intergroup conflict and the resulting anger and frustration.

'Like there's been thousands of times I've been in meetings, where I'd love to jump up and strangle someone but you control it and you know. You can't avoid in high pressure situations that people disagree. You've just got to get over it.'

'Emotion certainly if we are dealing with people in the IMT, the emotion can be driven by being forced to work with people we wouldn't ordinarily work with. And you know, personal differences you've had prior to that point.'

It was clear that emotion was not something that was well understood. It was often described as being high or low with little distinction between emotion types. However, those with experience in more severe incidents mentioned feeling hopeless, deflated, guilty, horrible, despondent, numb, confused and shocked.

The IC in particular is perceived to be under severe pressure because of the legal responsibility placed on him. A mine-manager acting as the IC has a lot to lose in such a scenario including his career and possibly his freedom, which is the reason several participants believe he should not lead the IMT.

> *'I said, 'Are you right?' and he said, 'no, not really' I said, 'tell me what you're thinking'. And he was worried about the ramifications, him going to jail, the public outcry, him getting the finger pointed at him and all that.'*

The impact of IC guilt on performance has not yet been explored sufficiently in the mining literature given the situation that the mine-manager is both legally responsible for the incident and the response. This factor is suspected of encouraging the IC to have 'agenda'. All of the participants who spoke about IC guilt were those with experience in multiple fatality incidents indicating that this issue is one that may not be expected by those without such experience.

An interviewee who has been a mine-manager and the IC at the time of a multiple fatality incident explained:

> *'Yes definitely, if you, as the responsible mine-manager for the place, you feel responsible for what happened and it probably takes the general manager or the HR manager or somebody to start interacting with you for you to understand that it's not just your personal problem. It might be a problem with the systems or the equipment but it's not just your personal issue. So at that point, relief is probably not the right word, but you feel less guilty about what's happened. You sort of move past that point and move to more rational thinking.'*

It is implied in this statement that whilst feeling guilty, guilt is not really the right word, yet he can't articulate it any better. It is possible that his struggle with the terminology is a result of him trying to regain emotional homeostasis by distinguishing between being personally guilty and legal guilty and possibly being guilty in the eyes of the families. He chose the term *'less guilty'*, implying some sort of guilt, but if he doesn't feel personally responsible, he can't feel personally guilty. The word 'guilt' is not necessarily the correct word, shame may be more accurate but nevertheless, it highlights how heavy the legal responsibility must feel on the shoulders of a mine-manager in this situation and how, because it does not tie up with the individual's own view of himself, cognitive dissonance may be employed to try and right the situation. How could he be blamed legally for the deaths of several men, when he personally he would never kill someone? However it is labelled, the resulting emotions are likely to be highly disruptive:

'It's a double edged sword for the IC because not only might he have to potentially go and speak to the families, looking at Pike River, or Beaconsfield, but he's probably had something to do with causing the incident in the first place. In his mind, he would think that they know that. So that's certainly going to mean some emotional stress for him.'

'The buck stops with the mine-manager, righto, so that means there's been a system failure in a manual system so you've got this burden of responsibility.'

It is possible that this assumed guilt may even unconsciously drive the behaviours that others see as having an *'agenda'* or *'arse covering'* because the IC will be highly motivated to right the situation as much as possible by desperately seeking evidence, or possibly creating it, to show that it wasn't his/her fault. The reason for this would be to try and make the legal viewpoint more like his/her personal viewpoint i.e. innocent. Therefore, it may feel more like exposing the truth than tampering with evidence.

A mine-manager's fear of the personal consequences was considered a significant source of stress. Participants spoke of the stress that they have observed in others, felt themselves or spoken about with mine-managers whilst managing emergencies. These included: a fear of litigation; concern regarding the consequences of decisions; scrutiny by the industry; their professional and personal reputation; the repercussions on their career; stress from being evaluated by the inspectorate and union; pressure from the families and media; and the feeling of being out of control.

Participants commonly spoke of feeling frustration because of not being able to do what is required because the IMT has set goals that are too high or too abstract; because there is insufficient resources or information to do the task or because 'Mother Nature has a completely different outlook'. Three mines rescue interviewees recalled the frustration of being called to mines but not deployed. Frustration at not being deployed was also problematic at Pike River compounded by a breakdown of communication:

'These boys they were climbing the walls and ready for mutiny, it was the word they used.'

Every interviewee who attended the Pike River mine during the response effort spoke of the frustration they experienced due to the *'dysfunctional'* and *'disjointed'* decision-making process. Dealing with the police who needed the most basic of mining terms explained to them, and then again explained when a new shift took over, caused intense frustration. Delayed decisions due to the delegation of decision approval to higher echelons of the police force and the fact technical groups were prohibited from working on contingency plans also significantly added to frustration. Frustration also arose because some felt the families were being given false hope.

'The mining people incredibly frustrated . It's hard to fully articulate the depth, feeling that the guys, when you walk into the room of rescue men that are sitting there and they can't do anything. You know. That total and utter helplessness that they were feeling.'

'I stopped actually stopped attending some of the IMT meetings for a while, I just found it so frustrating. You know that, you just knew the mine was going to blow up again, just the seriousness of the situation was just lost on the people. And there were so many political, command structure factors that were coming into play, it was so messy.'

The decision made by the police that caused immense frustration at Pike River was the decision to delay ordering inertisation equipment from Australia. Inertising the mine can prevent further explosions, but its use would kill anyone who remained alive underground. The police did not want this equipment brought to the mine because of the message it would send to the families, whereas the majority of the Australian mines rescue services personnel in attendance considered that having it on-site would be a sensible contingency plan.

Interviewees saw stress as integral to many non-technical issues:

'Well stress is an end result of fatigue, emotion, self-confidence. How do I, and the, you've got to have a shitload of courage. So, and courage is related to confidence, so yeah. If you haven't got the confidence or the courage or the other things I've just mentioned you are going to be stressed.'

And provided some examples of what being stressed feels like and the impact it has had on them or others.

'It's put my mind into neutral a little bit, from time to time, when I'm worried about more things than, rather than just assessing evidence on its merit I'm clouding the whole thing with a lot of other things, my minds not with it. Thinking about, shit, 'what happens if [not audible] and the pit blows up' or, have I informed these people in the right fashion, and the stresses of. And what's my family thinking, they know I'm out somewhere, I'm not telling them every 12 hours and they've heard on the radio. So there's, not focussing properly, and it's distracting, difficult to concentrate at times.'

'You just function, but you're almost numb. You know when you've been punched hard and your head goes a bit numb and a bit swimmy, that would probably be the nearest sensation I would say to being in charge. You just kind of, you're kind of divorced.'

The participants attributed stress to an inability to make decisions, a loss of problem solving ability, a diminished ability to achieve outcomes, being closed to *'suggestions and ideas and solutions'* and having difficulty taking in information.

Because of the prevalent belief that professional and objective decision-making cannot occur when emotion is present, most felt that individuals should *'Separate themselves from the emotion'* until the work has been completed and deal with it afterwards.

> *'you need to be as professional as you can possibly be, and there will be time for the emotional things afterwards.'*

> *'I don't care if you break down into a basket case, weeping and all that. That's fine, but do it somewhere else. Do it tomorrow when we've got some time.'*

Those that could not control their emotions were considered a risk to objective decision-making. One participant likened dealing with emotions to dealing with a spot fire,*'you need to get on top of it early'.*

> *'It is, it's gotta be controlled though. You can't be on an incident control team if you're letting emotions run your decisions.'*

> *'You've got to contain your own state of, whatever that is, arousal, emotional arousal. Or whatever, I don't know what the word is, but whatever the word is.'*

> *'You've got to get on with it. Worry about that later.'*

Several participants revealed that this is how they dealt with their emotions when they found out close mates had been killed.

> *'How I learnt was very, very early in my career, there was a bloke killed, we did everything we could, but we lost him, and effectively we carried him out and all the rest of it. And then I just walked down the back of the paddock and cried my eyes out. I was a blithering mess. And then I went back and I had all the what did you do and all the rest of it, and the lesson that that taught to me was that because I was so involved with trying to save this guy's life at the time, I didn't have time to be emotional. All those things we just spoke about. But, if I had, I didn't, just by pure circumstances, I also realised that when I did walk over the paddock, that I was an absolute blithering mess. So I said to myself then, if ever you are in the same situation again, never ever forget this. Because what you need to do, is do what you need to do at that point in time and then you can go over the back of the paddock and be a blithering idiot. Now, unfortunately I got to do that a number of times over my career. But that again comes all the way back to where you started from, what people are exposed to, life's lessons, and those things happening outside the industry as well.'*

'It's when you are not on the job anymore because all the other emotions come through, because you do, you suppress your feelings, and your anxiety and all the rest of it and you do, you just become this machine. But then when you are taken away from the incident because you've done your time and you are coming out on the transporter and you are in the shower, I'll be honest with you, I broke down in tears, I was on my own, did the debrief with the IMT, and went to the shower and I was all alone and that's when I had like a mini breakdown, I sorted myself, got dressed went back to the IMT and went home than came back the following day.'

'Well, I went round the corner, [pause] cried my eyes out for about 10 minutes. Had just lost a best mate. And I sat there and I said, 'right I can sit here and fall to pieces or I can get up and go and do the job I've been trained to do.' And, that's what I did... That was a really big learning curve for me and that's when I knew if the shit hit the fan, I could keep control. And that's, I've never ever forgotten it. You can't afford to lose control, because it could cost other people's lives.'

Another coping strategy that participants used was avoid the emotional stimuli. For example one participant tried to block out the wreaths placed on the bridge at Pike River describing it as *'horrendous'*. Two others, avoided finding out the names of those underground at Pike River by avoiding the tag board and not looking at the staff list. One explained this as *'trying to stay as walled as possible'.*

Two participants used the term robot to explain how they have felt working on recovery operations:

'I think for me, you almost become a robot, you just operate, it is strange, you are just doing what you need to do, it's almost as if a part of your mind switches off. And this is the most comforting thing after an incident, after you've had the shock and you are still involved the following day, you actually feel better, well and in control when you are back on the job.'

'almost robotically went through the motions, it was fine, and that sort of helped me really, that sort of focussed me into, I suppose I shut out the emotions, I don't know how, almost clinical, almost robotic. I found the tactics easy to do then got back to the station and lost it.'

Recognising and dealing with others' emotion and stress

This element is about understanding and being able to deal with others' reactions to stress and emotion when the IMT is dealing with a serious fatal incident. Understanding that potentially unusual or offensive behaviour may be the result of stress, and unintentional, may reduce the observer's likelihood of taking others' behaviour personally and retaliating causing increased conflict.

'I've never been hugged by men more, than at explosions.'

'I mean I know someone that I know will yell at me when he is under stress. That's kinda what I'm thinking. What do I do there, you know? Tell him nothing? Just tell him what he wants to hear?'

'The IC needs to be that special kind of bloke that really understands the team and those emotional things.'

Some interviewees recognised that the environmental stress placed on those involved in an emergency has the potential to alter the behaviour of team members to an extent that makes them unfamiliar. One claimed that you can't know how people will react when it's *'crunch time'* and another spoke of *'skitty'* people who have surprised him by being good under stress and the opposite was also noted of *'strong'* people. However, others believed that if an IC knows the team the IC will know how they will react.

'You can assemble a good team around you that in peacetime are very good technically etcetera. But then, when it's crunch time they just can't handle the stress. And that's something that you can't really determine.'

'I would hope that I have a good understanding of their experience, their performance under pressure, in a workplace, I mean you can never, if it's a big ding, well, unfortunately sometimes people just snap or they step up'

'for persons in a senior management role, under managers and managers, that they should have to do some, some psychology, I don't know if that's the right word, some psychology - understanding people's emotions, and reactions or potential. Because I've seen perfectly logical people going to screaming neeby jeebies when they've been faced with something challenging. And I've seen other people stand tall, and not necessarily the people that you'd expect. So to see that happen, it's scary to think of the people that we've got in control of these people that wouldn't understand, or couldn't deal with it.'

'If you don't have a personality or psychological profile of the people, you don't know what you get. Because when things become dynamic and emotional, or when you are involve dynamic situations and emotions, people change.'

'You might be a fantastic ventilation officer that can give me any kind of sets of figures but now we are making decisions that might kill someone or help them survive... can you do it?'

Another noted that this should be planned for:

'They could do what was asked of them, but you knew then not to ask above that' so a strategy of 'being aware of it, but also having a plan B in case someone does let go or just can't handle it. A reserves bench that you can just sub them from'.

Monitoring others' personal limitations was deemed important and therefore having the right team was considered important so that others listened to those telling them to take a break.

'If someone sees it and they tell you, and you move aside.'

'[if] someone says, [name] you've had enough, go and have a lie down, because they will identify it before you do. That's why it's important you've got the right people.'

Other participants acknowledged that the ability to perform under stress was intra-personal. That one day a person could be OK, yet struggle the next due to circumstances in their home-lives.

'in England 25% of the population are depressed at any point in time. In some cases that might be for a day, or it might be for a year, so on averages. If you have 10 people in the room that form you're IMT team, 2 are suss to start with, 3 of them probably haven't had enough sleep, 4 of them might be mortgaged up to the hilt, and the other one might be in the middle of a divorce, or 2 of them in the middle of a divorce, bang, bang, bang, and the IMT leader is a raving idiot.'

'And one day you might be right to go and the next day you might not be. Because your dog has died or your uncle is very, very sick. Or one of your kids is in hospital and it plays on your mind.'

'Well all you can do is emergency exercises and see how you go. But you're still not going to know how you're going to go in a real one.'

'Look you don't know who's going to perform or not going to perform until it happens.'

The behaviours that participants believed indicated that others were not coping with stress included: becoming snappy or short; being aggressive; becoming reclusive and quiet; their voices go up in pitch; they *'take a personal attack and make it into an argument'*; only hearing what they want to; not taking information in, making technical mistakes they wouldn't normally make; focus on one thing only (usually what they are achieving success with) and losing the overall picture.

'In one particular case, one person almost broke down, their posture and their demeanour, broken voice and crumbling if you like. It was a matter of propping him up or exiting him.'

'this one guy really surprised me, he really just fell apart. He became so obsessive about little things that he wasn't even thinking of the big picture stuff. He really fell apart.'

'I've seen it, where they get swept up in the emotional side of it and they're fixated then on one particular part of it'

'You wouldn't believe, people will follow a path where they get success. So if at the beginning of the day your objective is to rescue 6 people. And you can have a couple of objectives - save the mine. If that involves getting the fire brigade involved and laying 4 km of hose and put a pump here and 4 people there and 6 people there. If you start getting success on that, that will become the focus. And you've got to say that's been done, forget it, let someone else do it, let's get back to how we are going to do this. And yeah, success breeds. You get satisfied because you've had success so you keep focussing on what you are doing, not what your objective is.'

Participants noted a need to know yourself well, and *'understand your own personal failings'* as a pre-requisite to being able to evaluate others. One participant described how learning about his own behaviour has helped him reduce conflict with others by not retaliating to their behaviour:

'Well if they are a bit prickly then I'll match their prickliness, I'll match you a swear word and I'll throw a couple more in. So that was just poor. So a bit of self-reflection on what I've done, and how I've badly handled people in that type of situation, I'm trying to develop my own coping skills about how to handle the pressure, and not to get swept up in that emotional type stuff.'

Fatigue

Fatigue management and succession planning are now an integral component of emergency management planning in mining. Almost all participants spoke of the importance of managing fatigue and it seems accepted that cognitive functioning reduces as fatigue increases.

'I said, 'get outta here, you actually can't even construct a sentence.'

'I know I've made some ordinary decisions being tired.'

Four aspects of fatigue highlighted in the interviews, that are not common within mining literature, include:

1. the effects of adrenalin on fatigue;
2. the effectiveness of fatigue management plans;

3. the role of fatigue in increasing interpersonal conflict; and

4. the attitude that fatigue is an issue for everyone else, but not me!

Most participants thought that if they were running on adrenalin they were not fatigued

> *'Well it is, but , when you are actually, fatigue doesn't set in, from experience, when you are in the thick of it. Your body just doesn'tsuccumb to it, you know what I mean, when you are really on with it. But once you get pulled away from it it hits you hard. It's a strange one fatigue. And the stress of it makes you more fatigued.'*

> *'To a point. I don't know what the scientists say, but when you are running on adrenalin you can go for a long time. As long as the brain is continuing to work, you can go a lot longer than what you think. And I've seen, I think up to about 20 hours, might have been longer, but they were still going, I don't know if they made any bad decisions but they were still going. And that's probably not acceptable. I guess the issue is if it's a big recovery and you need to be there every day, then you've got to get to the point where it's, 'I can't be here tomorrow if I'm here past this time of night tonight.' Cause otherwise it will just, down the track you'll just hit the wall and need replaced.'*

Fatigue management plans are implemented to ensure that workers get sufficient rest between shifts. Most fatigue issues arise in the first days of a protracted incident because people are reluctant to leave site. The desire to stay usually affects those most closely affected and the mine-manager/SSE who would remain technically responsible even if he/she was resting. People working on a protracted body recovery operation have been especially reluctant to leave. Participants spoke of not wanting to miss anything and the *'excitement'* or *'buzz'* of the ongoing recovery efforts. Both participants noted the inappropriateness of these words but couldn't think of a better alternative.

> *'it's like you are pumped up on what you are doing. You almost get a buzz out of it for want of a better word. It's really strange honestly.'*

The benefit of leaving site was questioned with participants speaking of setting up beds on-site. However, they held conflicting views on the benefits of this. Others spoke of not being able to turn-off when they got home anyway meaning that IMT members may not be any more rested after having taken the obligatory time off.

> *'yeah right, you've got 29 men in a pit how can you possibly go and get good rest? And not being told stuff, when you are at, when you do go home, to try and get the rest, the thing that keeps me up is not knowing what's going on at the pit at the time.'*

'And then the problem is with a real incident, you live the incident, and then you go home for your rest and you can't sleep. And then you do return to work fatigued but once you are in that job again, I don't know what it is whether it is the adrenalin or whatever it is just totally takes over.'

'But when I sat in my car I still found it hard to wind down. It wasn't until I got home I started to, but when I went to bed I'm still playing over everything that happened. Because I knew if I went to sleep I might forget things so I burnt that into my brain so that first thing in the morning when I get up I can make notes and then I could write my report.'

'And if I do take 2 days off am I actually going to rest? I'll probably be worse. You actually function better at work when something is going on. I don't know, well I do know why, it's the involvement, and the knowing what's happening and the not making it up.'

During a protracted incident it is not only rest that is needed. Several participants spoke of the need return to normality for a time and to see their family to ensure ongoing productivity.

'I never got too tired at any stage. What I needed was a weekend where I got home for the whole weekend. I wanted to see my kids. Just to hang out with them and not think about the mine.'

The third point is that although interviewees recognised that fatigue could affect their own and others' behaviour, and that this can increase interpersonal conflict, when it came to their own poor behaviour due to fatigue they assumed others would understand this and deem their behaviour acceptable.

'And I suppose I, the fatigue bit, yeah, we were all pretty tired, by the end of it I was a cranky bastard. And, I remember having some very big arguments with my management team, but we all knew that none of it was personal.'

'I was trying to save the mine, I was trying to save the jobs of our employees, but a couple of days when I lost my shit. I think people sort of went. Anyone who was there during the whole time knew how many hours I had done.'

'I'm terrible on nightshift… if I'm tired my fuse get that long [small space between fingers]. It's very unpleasant. I'm sure I made some pretty wrong calls in my time too. When people have told me stuff that, 'let's do this' 'No, screw you, we are doing that, that's just what we are doing, cause I'm telling you, that's what we are doing' and it's just, you get out of the mine and have a cup of coffee and you look at the report and think 'oh shit, maybe we should have done."

'talking about fatigue and emotion, they certainly, things that affect the way we deal with other people. Certainly for me, they are all connected, the fatigue will be the catalyst for emotional change for me. I tend to shut down, look to take a quieter role in some situations.'

'But, they could tell that I was tired. And I can tell ya, towards the end I thought about just strangling this bloke [the IC] and putting him out of his misery. And, I just sat there with a smile on my face and thought you are the biggest wanker I've ever met and I could strangle you - but I had a smile on my face. It wasn't worrying me, it was just a thought that went through my head a couple of times.'

The fourth issue was the tendency to see fatigue only as an issue for others.

'I've fallen into that trap myself. I'll tell my team they have to stay the night, then I'll jump in my car and drive 4 hours home instead. That's just what we do.'

Two accounts of the same incident revealed this tendency. One participant spoke of a conversation he had had with friends who had been working 16-18 hour shifts during an emergency. They told him that adrenalin just took over and fatigue was not an issue for them. Yet, another participant who actually attended the mine stated:

'they were all pretty buggered', *'they were pretty much screwed physically'*, *there were a lot of interpersonal plays we could see in the background. He wasn't talking to him and if you wanted to get something done you'd ask this bloke round the back of the bikeshed type stuff'.*

Self-confidence

Self-confidence, if too high or too low can be a limitation. Several participants with experience in serious incidents stated that they had observed low self-confidence in others. This was based on their observations of endless searches for data and decision-making procrastination. If the interviewees' perception that low self-confidence is at the root of this behaviour, self-confidence could be an important issue to address given the frequency of this behaviour being observed. However, only one participant spoke of his own battles with self-confidence. It seems possible that others have felt this but were unwilling to share it.

'Yeah, the self-doubt is a killer, I've found that to be crippling'

'those guys can look at it and make a determination fairly quickly and accurately. Me, not as much because I don't have their experience and I'm not as confident.'

'Being able to control that [self-doubt] in the last few incidents, and having the confidence in my ability to operate, technically, dispelling that self-doubts, so having a bit more confidence in myself, that's helped immeasurably'.

Low self-confidence may be at the root of some of the situation-awareness and decision-making issues that have been noted in Level 1 exercises. Participants interpreted behaviours such as *'clutching at straws'*, *' running off on tangents'*, *'wanting more and more information'*, *'procrastinating'* and decision-making *'paralysis'* as evidence of low self-confidence in the decision-makers.

The participants believed it was particularly important for the IC to have self-confidence to be able to *'question things that don't ring true'*, to be able *'to manage highly intelligent, highly competent people'*, *'to keep going when things go wrong'*, *'to be able to make the final call on decisions'* and to keep things moving at a reasonable pace.

> *'I've seen mine-managers freeze and doubt themselves but at the end of the day you've got to make a decision and you've got to hope to God you make a good one.'*

> *'The more self-doubt that comes into it the less confident you are to make a call and the more other people you want to tell.'*

> *'the ones that I've seen, [he lists the IMS he's been in] the decision-makers really don't want to make a decision until they have some sort of consensus with every man and his dog, I don't know if that's to share jail cells or not..., I don't really think they had the confidence to make a call that seemed to be way outside of what they normally do.'*

> *'They procrastinate, it may be their level of understanding, outside of their comfort zone. Also a males ego, doesn't want to say they don't know.'*

Interpretation of the participants' comments suggests that people need enough information to be confident but if they lack self-confidence they may never feel that they have enough information to make a decision. This may be a serious contributor to the delayed decision-making often observed in simulations.

> *'If it reaches that point where we don't know, whether we don't know because we don't have the information, or whether we don't have the level of knowledge to make the decision that must push that stress level up to the boiling point, where they don't have the ability to make effective decisions.'*

> *'How much information is enough information is a problem' Every group I've been in that's been dealing with a fire or explosion, or a spon-com, is the thirst, the lust for information and if you've got this much and you are still not confident you need that much (hand gestured), you need more and more. You are never happy with the amount of information you have, so to make a decision on that much, 'No, no we couldn't, we should wait til we get a bit more."*

'It's your level of tolerance as to how much information you need to have the confidence to move forward, to move on.'

The stress experienced in the emergency environment may be partly attributable to lacking self-confidence yet others noted that low self-confidence could be a result of stress.

'when there's dead people involved and there's smoke and fire involved, when there is an explosion involved, it all seems to unravel and no-one can make a decision because they are not confident and they really don't know what to do with it. Or, don't want to make a call just in case it's not the right one.'

'Well stress is an end result of fatigue, emotion, self-confidence. How do I, and the, you've got to have a shitload of courage. So, and courage is related to confidence, so yeah. If you haven't got the confidence or the courage or the other things I've just mentioned you are going to be stressed.'

Self-confidence may directly impact decision-making because of the IC's own personal limitation with self-confidence issues, but may also indirectly impact decision-making via its influence on other social issues. Participants' accounts of low self-confidence indicate that it may be the catalyst for some behaviours associated with interpersonal conflict such as *'ranting, raving, yelling and screaming'*. This could impair collaboration and communication and the IC may find himself becoming more isolated and stressed, creating a vicious cycle of events that continue to diminish his/her self-confidence and decision-making ability.

It is possible that the common call for more assertiveness in an IMT is partly a self-confidence issue.

'Also knowing when to speak-up and having the balls to do it.'

'hopefully that person would have enough balls to say, look this is what I think can we go through it in case I've missed something. Because we are not all experts on everything.'

'Being able to give the IMT confidence that people can speak their, if they're not sure they can say look I'm not sure about, I don't know if that's right, what about this?' 'at the moment about 50% of management in coal mines have an aggressive style. This links to the confidence of people in the IMT, they may not want to speak-up for fear of being skinned alive'.

Two participants noted a distinction between being competent and being confident. A lack of self-confidence is not necessarily directly related to not having sufficient technical ability. It is the individual's perception of their ability that is the key, and this may be affected by the stress of the emergency.

Training and experience in technical and non-technical skills was believed to enhance self-confidence. Other strategies discussed included phoning a trusted colleague to run ideas past before getting to the mine-site, bringing in technical experts, reflecting on past performance and undertaking personal development.

> *'Going through in my head about what priorities we should have, what things we should do, what questions I should ask when I get there. But the best thing that I've been able to do is ring up [name] or [name] and say listen this is what I've got, this is what I think is happening , this is what I intend to do. You know, what am I missing? And just from them saying 'have you considered this' or 'that sounds fair enough' is enough to settle me down and I can walk in confident.'*

Over-confidence was not explicitly raised by the participants, yet it seems implied in the discussions about the mine-managers who believe they can control the event single handed. The literature suggests high self-confidence can be good to minimise stress [118], but can lead to over-confidence in the predicting how the situation may develop [201].

5.3.7 Communication in the IMT

Items discussed in this category are relevant to all of the other non-technical issues discussed because verbal communication is the primary mechanism by which situation-awareness is achieved.

For example, interpersonal trust and communication appeared highly dependent. If someone was not trusted, or suspected of having an agenda, the content of what they are saying was not listened to and communication ceased completely on a number of occasions discussed.

> *'You can virtually feel it amongst a group of people if somebody's speaking and the group doesn't trust the person it doesn't matter what they say.'*

Communication breakdown is a recognised failure mechanism for teams [172], and unintentional communication errors and failure can occur during the communication transaction, when messages are misheard, misunderstood or otherwise distorted. However, the large number of examples of people deliberately failing to contribute to IMT meetings or with people they had conflict with, is concerning given the critical role of communication.

> *'I just ignored what he [the IC] said'*

People have intentionally stopped communicating in IMTs for several reasons, but the most prevalent catalyst was conflict between individuals. Similarly, intergroup conflict has affected communication in the past, when agencies have had, or been perceived to have, different goals and priorities.

In summary communications have failed for the following reasons: taking what others said to them personally and withdrawing from communication; when there was a lack of respect;

when they felt their comments were not listened to; when others were overloaded with work; when personalities clashed; when they felt intimidated by external agencies such as the police, or the mining inspectorate; when team members were perceived to be interlopers at the final stages of a rescue or recovery; when people were rude and spoke over others; when people felt emotional or froze and shut down completely; when people were frustrated with others, when the process or the quality of the decisions were deemed poor; when they were scared of incriminating themselves; when the listeners were not trusted; when they were being recorded or minuted; when their contribution was not valued; when the IC was too dominant or aggressive; when someone was perceived to have an agenda; when the other person was disliked; when people were not seen as competent enough to use the information and a fear of the reactions from others including ridicule or aggression.

> *'I noticed that that was being recorded, so that shut that down pretty quickly. I learnt not to say anything in the [IMT] room.'*

> *'If someone's hammering me with all these questions and they are not listening to my answers. I'm going to shut-up, everyone does it. So people have to be mindful of, 'shit, are we loading this guy up?' '*

Communication in the IMT - To challenge and be challenged

This element addresses assertiveness issues but the term assertiveness was not well understood and was commonly interpreted as aggression, dominance or being offensive. If the word was used, participants tended to lessen its impact, for example, *'a little bit assertive'*.

> *'So there's a reasonable amount of assertiveness but not that overarching dominance.'*

> *'Yeah, in a sort of... assertiveness in a respectful way. I mean if you do it in the right manner.'*

> *'Well, I don't think necessarily the assertiveness thing comes into it at that stage. They don't have to be like, 'no, you are wrong' but willing to say, 'well, have you thought of this?'*

However, most participants recognised the need to *'challenge the data'* provided by others and to be prepared to be challenged themselves when presenting data as part of the validation process. A supportive environment and mutual respect was seen as a prerequisite to facilitate this without people taking offence or feeling frustrated or threatened.

> *'Challenge the process. Don't challenge the person. So by challenging the process, you know, 'how did you get to that decision?' 'Where's your process?' Yeah, don't attack a person.'*

'If you challenge basically, you can challenge respectfully and basically you can go through a what-if exercise to get to the, to confirm to yourself that what you've been told is the complete answer.'

'We've also got to be prepared to question, and the team itself has got to be prepared to let somebody challenge them.'

'And also I found it myself when people listening to me, and they want to question the stuff I've came up with then I sometimes feel threatened by that.'

'We've also got to be prepared to question, and the team itself has got to be prepared to let somebody challenge them, even if it's a dumb question. Sometimes they are the hardest to answer.'

'And some people, when you do question them, they start calling you. They take offence to someone of my limited experience questioning them... So calling you 'son' and trying to pick holes in your technical knowledge.'

'One of my philosophies of life is don't ever go into a meeting with an opinion if you are not willing to voice it. Now I'm quite happy to have that overturned, or logically argued out that what I'm saying is not the best way. But don't stop me from saying it.'

Similar to the co-pilot to pilot assertiveness issues identified by non-technical skills researchers in aviation, some ICs wanted the team to challenge them more:

'if someone thinks I'm making a wrong decision I want them to tell me. I don't want them to just bloody accept it blindly and move on. That's how we make mistakes, so you want them to be honest and tell you.'

'people need to feel comfortable challenging him [the IC], right.'

'people are sometimes afraid to speak-up with information they think might not be what people want to hear, and prefer to tell it one on one instead.'

Communication in the IMT - Creating an IMT environment where people can speak-up

Maintaining communication in an IMT is reliant on creating an environment where people feel comfortable to speak-up. It was viewed to be the IC's role to develop an IMT environment that encourages open communication. Many spoke of dominant or aggressive IC's behaviour as being detrimental to this because people will not speak-up for fear of being *'skinned alive'*, thus impacting communication and reducing the likelihood that decisions would be made collaboratively.

'We've got some good ... managers out there but there's some Nazis amongst them who scream at their people day in and day out. And I'm telling you now that there are people out there that would be afraid to come in in an incident and say, challenge them, or dare bring in the wrong information.'

The IC who does not create an IMT environment conducive to communication, was often described in terms of his personality rather than his behaviours. Example include: *'big tough bastard'*, *'overbearing bastard'*, *'overbearing person'*, *'very strong willed people'*, *'those types of people'*, *'big bombastic bastard'*, *'dominant personality'*, *'strength of personality'*, *'strong personalities'*.

'One of the other things that is really challenging is when you get a really dominant person, that can be counterproductive too, where they have such an aura or rule by terror that logical, intelligent people that have valuable things to say are either howled down or ridiculed and it becomes a one man show. And that's so dangerous.'

'A dominant person can sway a group.'

'The baseball bat theory is based on fear.'

Such leadership has encouraged team members in the past to resort to doing their own thing, without IMT input, further eroding communication and collaboration.

'Yeah, cause they were scared of this bloke. You've got to imagine that a good make up of that IMT was people from their mine. So they're sort of. You hardly heard boo from them. And when they go out you'll see them in a huddle with him and then go off their different ways and do whatever they are going to do.'

Several of the older participants explained that they had used an aggressive management style earlier in their career but had found that this approach, and in particular the way that they communicated with people, did not get them the desired results so have since changed their leadership and communication style.

'also in the way I've reacted to, to, people in a bit of an agitated way at the pit in the past, in not so good management mode I've managed to match their agitation and that hasn't helped in the slightest.'

'I've probably been in a position when I was a lot younger, a feisty... in my youth, where I don't know, it was probably perceived back then that the louder and more upfront you were the easier it was to get things done. As opposed to with age and maturity saying well that's not necessarily the best approach because people will walk away and say, 'Geez, he's a cranky bastard' rather than 'I don't mind doing that for him, because he's always..'

'Respect or caring. I suppose history has taught me, if you take an aggressive approach to people you are wasting your time. So I like to speak to people in the manner I like to be spoken to.'

'You get in my way, I run you over. Then when I became a mine-manager, and I'm in charge of 300 people, I can't be like that anymore, you know.'

'I listen to people a lot more. I was a very aggressive undermanager. ... More thoughtful of other people's feelings and definitely more thoughtful of thinking about what I'm going to do, or tell people what I'm going to do before I do it. So maybe that's more safety conscious, perhaps it is. Certainly more attune to other people's feelings and less aggressive. Definitely less aggressive.'

Communication in the IMT - The communication transaction

Communication can unintentionally fail when an issue arises during the transmission and receipt of a message.

Listening serves a dual purpose, it is required to ensure receipt and understanding of the data, but it has also been highlighted as a critical component of showing respect and maintaining communication in the IMT. Participants highlighted the importance of being acknowledged and appreciated if they were to continue contributing to a team.

'So when the listening time is on, you listen. And when the talking time is on, and it's your turn, you talk. The other thing is that person has the capability of when they are listening, at the same token jot important points. So I'm listening to you talking away and you mention Joe Bloggs saw smoke, I'm not going to cut in and say is that at 7 cut-through? But when it's my turn, I will say please clarify this, this and this.'

Participants had observed people who had not heard messages at all because they were preoccupied or had not taken-in the information because it didn't fit with their understanding. Others explained the need to listen carefully because different people may explain or choose to do things differently, but that does not mean that what they are saying or planning to do is actually wrong or even different.

'I've seen problems at mines where we've had roof failures and someone said something and it's just gone over everyone's head. And I've heard it and said well 'so and so just said this before and no one reacted to it'. Say it again. Oh I didn't hear that, because they only want to hear what they want to hear. They are focussed on, we want to get this done. They are listening but not listening.'

'It's people's perception of the words you say.'

'I have been aggressive before and direct and I have found out through experience that what I necessarily want, someone else mightn't perceive it the same way and what they deliver is exactly what I wanted but it might not be in exactly the same order as I wanted it but the end result is the same. Listen to them.'

'what we need to remember is that there is more ways to skin a cat. And just because someone wants to skin the cat this way, and someone wants to do it that way, the end result is the cat skinned. And this is where people, 'oh, you're doing it my way' and they won't listen to how somebody else wants to do it. And at the end of the day, if the end result is the same and either are just as safe as each other, then fair enough. Some people are not good at listening to others' point of view.'

Communication in the IMT - How to speak to team-members

The participants indicated that the way a person is spoken to can precipitate a communication breakdown, and can encourage or discourage the best performance from others in the emergency environment. Participants highlighted the importance of being acknowledged and appreciated if they were to continue contributing to a team. This element is therefore about how people speak to people rather than what is said.

'it's not the time to go shouting, the last thing anyone can do is shout and rant and rave, cause that just brings everything to a grinding halt, [and] takes the focus off where they are,'

Aggressive and rude behaviour such as ranting and raving, shouting, outbursts of anger/tirades, screaming at people, and talking over people were all seen as particularly unacceptable and have been seen to disrupt the emergency management process. This is particularly unfortunate if these behaviours are precipitated by low self-confidence as these behaviours will not engender support from others.

'His little outbursts really upset the dynamics of the meeting. Instead of asking in the IMT they were coming behind the scenes to get information.'

'If someone's standing and screaming at you, you don't feel motivated to go and help them.'

'screaming down the controller's phone is not going to help me get information any quicker. You've got to understand that.'

Participants stated that people should speak in a manner they would like to be spoken to, that the way people spoke could indicate care and respect, that eye contact can make you feel valued and was important, as was diplomacy.

'I suppose history has taught me, if you take an aggressive approach to people you are wasting your time. So I like to speak to people in the manner I like to be spoken to. 'It's just how you deliver your request.'

'I would be very conscious, of how am I going to tell Ruth that what she just said was absolutely silly and we need to look at it another way. This guy would just say,' Ruth you are a dickhead' and I'd cringe. I mean he could have done that in a better way. But I got used to him and I could see when he was going to be brutal. And it wasn't always good that he did it because he had that effect that I said before, people just shut up.'

'And one should be careful not to shut people down, if someone is talking give him the floor so he can justify what he's trying to promote. Because if you are in a rude manner or way you talk over him or you ignore what he's saying he may shut down and just not participate.'

'But the environment, and once again all that will be driven by the IC. If you bring it up and he goes, 'I told you [and bangs fist on table], that ain't gonna work. People start to shut down and you can't have that.'

Another communication skill identified was the ability to talk to different people differently, to ensure the message was delivered in a way the recipient would understand ranging from the underground crew to external stakeholders.

'You've got to be able to understand what they are saying, you've got to basically talk in their language, describe it in their ways and understand enough about what they do to actually test what they are telling you and validate it'

'The way that he deals with people at different levels, so he can change the way he speaks to people at different levels. Like a coal mine worker, he's talking at that level, not technical.'

'I suppose it's all down to relationships with people. I know I've got a group of people and I know I talk to this guy differently to the way I talk to this guy because each one has different needs and wants and you need to understand and acknowledge them needs or wants and treat each person as an individual not the same. Because if you treat everyone the same, one might be happy when the next one isn't.'

Similarly several participants spoke of times they had to modify what they said to suit the context of the situation. For instance there are times when the IC needs to be *'strong in giving directions'* whilst at other times, especially during fatal incidents, more diplomacy is required. One person spoke of a time when he was trying to get information from a man who had been involved heavily in an ongoing emergency response operation

'it felt wrong in how I was going about it but it seemed to be helping, I generally wouldn't be buttering up, it would almost turn your stomach if it was day to day work type stuff. But because he was so far that end of the emotional scale, it was difficult to get through to him any way but the nice way approach.'

'There is a time to be clinical and direct and there are other times you need to....it's the way you broach the information like, 'I could be wrong, this is what I think' , you never told them, 'this is the way it is.'

Finally, it seems that general care around word choices and topics of conversation are also important. Poor word choices have resulted in interpersonal conflicts, physical altercations, and guilt on the part of people who have unintentionally said the wrong thing. Terms such as *'skeleton crews'* and *'victim'* have caused upset in the past as have people being too cavalier and having inappropriate conversations at inappropriate times. However, those who had worked with emergency services, acknowledged the role of humour, often black, in helping people cope [68].

5.3.8 Leadership

Coal mining is not a people centred industry. The focus is on production, and the skills valued and rewarded in a mine-manager are those that maximise production and profit. Whilst some saw it necessary for the IC to have good technical skills, some thought the IC only needed enough technical expertise to challenge the data in the IMT and that it was more important that the team had the appropriate technical skills.

The non-technical skills needed to be an IC were perceived in most cases to be different to those required in on a daily basis, and were said by some to be completely absent in several current mine-managers. Most interviewees believed that more people skills were required of an IC than a mine-manager during daily operations. Few claimed that a good mine-manager had the necessary skills to be a good IC, and only one stated that there was no difference in the skills needed in an emergency. However, it is difficult to believe that mine-managers have honed their interpersonal skills, such as communicating with and understanding the limits of emotional or vulnerable people to the level of individuals employed in caring industries where they use their skills in emergency situations daily, such as members of the emergency services.

'Anyone can be trained to run a coal mine. But not anyone can be trained to run an incident management team when there's been a disaster, because everything changes. It changes from normal production mode to everyone's got personal feelings involved in a disaster.'

The ability to be a good IC was often attributed to their personality, and therefore that some people that just cannot be, or even be trained to be, a good IC.

'I don't know how you train someone to do that. I think it's in their nature, it's in their personality or whatever you want to call it'

'it's not the technical ability, it's their personality, so it's, and you can't. How do you teach people? You can teach people, but it's very hard.'

'Like, some people, have got it or they haven't. Like and you can't, and some of that stuff you can't teach.'

Participants also noted that good leaders had a certain presence, something that was harder to define:

'I don't know specifically what it is but some have the, almost an air of authority, I don't really know how to...'

'The person who is going to lead an effective ICT is the person that is perceived as a leader before he goes into the ICT.'

'The boys, everybody at the mine... needs to see him as the leader.'

A good IC is one that motivates the team to work because they want to, rather than because they are told to:

'You can tell he's a good people person, so he can get people to do what he wants them to. And they all look up to him.'

'I think a good IC would be a good leader, not necessarily a good manager. A good manager is a person that just gets people to do the right thing. But a leader gets people to want to do the right thing.'

'He's got to get the best out of people.'

'He just had good people management skills. He could get people to work for him, he could get people to do what needed to be done without pressuring, he had good authority, he was seen as an expert in that field, even though he could have been one of the people responsible for what happened, he didn't change from the job at hand, he was the Incident Controller.'

Leadership - Communicating externally from the IMT

This is one of the bigger picture roles the IC is believed to have. Interviewees emphasised the importance of controlling what IMT members say outside of the IMT room to manage perceptions of the IMT's efficiency.

> *'Communication is just so critical, once again because you may be able to draw in some information, plus it's also keeping people informed and confident that you are in control.'*

Experienced ICs explained that communicating with the mines inspectorate, head office and the mine-workers is necessary to build these others' confidence in the IMT. The mines inspectorate must have confidence that the IMT decisions pose no risk to employees, because they can take control of the mine if they believe safety is compromised. Those of higher authority than the IC in the mining organisation must have confidence that the IMT decision-making is optimal for financial reasons. Equally, the mine-workers must be informed of progress, to maintain their confidence in the IMT, because these are the people actioning the IMT decisions.

> *'Have the confidence in the IMT that we are actually doing stuff, and there's something happening, time flashes past when you are in there, but when you are outside it drags. And I've been on both sides of the fence. Outside thinking what the bloody hell are they doing, it seems like hours and hours and hours.'*

Control of information that leaves the IMT is vital to ensure that external stakeholders and the mining teams receive a complete and factual account rather than rumours or snippets information that can be misinterpreted. Maintaining the confidentiality of some issues discussed in the IMT is seen as imperative, and when confidentiality has been broken, trust has been lost and this is detrimental to progress.

> *'And that's a really important skill, non-technical skill, is to be able to be discreet, confidential, because that's what breaks down the team, you know the rumour mongering and that sort of thing.'*

> *'They also have to realise the power, if they walk out and go, 'fuck I don't believe that shit' that also has an impact.'*

Leadership - Delegation vs micromanagement

MEMS relies on delegation to enable the IC to focus on decision-making and this was one of the more recognised elements of leadership. Within MEMS, micro-managing is evidenced by someone interfering with, or carrying-out tasks that are the responsibility of someone lower in the hierarchical structure.

'I'm going to let planning, logistics and operations do what they need to do, and don't interfere.'

All but one of the interviewees believed the IC must delegate because: one person physically can't do everything that is required in an emergency; jumping into other people's roles means that you are not doing your own; and if you don't step back from the detail you will miss something critical.

'It's not all about one person, one person can't do everything, so we've got to be prepared to delegate.'

'But when the shit hits the fan they are physically not capable of getting the job done cause there's too much.'

'[The] IMT leader has to take that holistic approach and stand back and allow people to do what they need to do. I mean I could look at several of the roles and feel like I could jump in and do them roles equally well or better but I've got to refrain from doing that because the Incident Management is the whole thing. It's not just one little aspect. So by jumping in and doing this guy's role you are not doing your own. I think a good IMT leader is one that can do that.'

'let's go off and do this, let's go off and build a stopping here, let's go and put that fire out, it's no good. That's for the other people to do, and the guys that are in charge, and that's one thing it's definitely taught me is you've just got to stand back, delegate and make sure that you are over everything , because if you are not you will miss a piece of the puzzle that is just critical, absolutely critical.'

However, delegation is not easy task for some.

'In hindsight, when you go back and reflect on what happened in an incident you feel like you were bombarded by information and by requests but when you looked outside you saw there were a lot of people doing nothing but you didn't have the opportunity to shed work or to manage it. So, sometimes I don't think I'm a very good manager.'

The likelihood of micro-managing was also often attributed to an IC's personality. ICs who think they know everything and others know nothing were perceived to be the worst micro-managers.

'Control freaks have every faith in their own ability and no faith in others. I can do it. You can't. And control freaks fail to delegate and the whole thing turns to shit.'

Alternative explanations included that micro-managing is a result of not trusting the team.

'The IC needs to trust, he cannot go in and micro-manage'

'you have to trust your people because if you don't trust them you are going to be stepping in and sitting on their shoulder. You've got be able to let them go and get on with their job, so you've got to trust them.'

A novel suggestion from an interviewee was that micro-managing may occur because those issuing the tasks have difficulty communicating what is required or can't visualise the outcome of the delegated tasks. This could be a problem with projection - the third level of situation-awareness.

'I think trust is a different thing to the delegation thing. Delegating, I know that they've got the ability to do the job. Trusting to me is more of a feeling word, you know I don't have that big an issue with requiring trust.'

'I think people sometimes make a rod for their own back, if you don't give someone enough instruction to go off and do the task, perhaps they don't understand themselves exactly how to communicate that or perhaps they don't understand exactly what's going to happen when they do something.'

IC micro-management has been seen to completely disrupt the management system, with roles and responsibilities becoming unclear and the big picture management of the incident compromised due to the ICs attention being focussed elsewhere.

'Understand your role, understand what that role is, and don't do someone else's role, don't dip down, and that's really hard, that's the classic, keep having that reality check, understand you own traits, if you do someone's job, they'll do someone else's, then there's no one looking at the overall perspective.'

'That comes down to management skills. The micro manager at a mine would be at risk of getting distracted and [inaudible] down when he has other resources there to take care of that. And he should be looking at the big picture.'

In addition, possibly due to the association of mistrust with micromanagement, it can lead to conflict within the team.

'If that Incident Controller starts micro-managing then the whole thing is going to turn into a piece of shit. And I've seen that happen.'

'If you start to micro-manage it's all over. I'll go, cause this is where it breaks down, 'You fucking do it, there you go, you do it!' You know? I'll go and sit over there.'

Most of the participants who thought the IC should not leave the IMT room between meetings explained that this was necessary to prevent the IC micro-managing. Of those that believed that the IC should observe the teams to get a feel for the emergency management process, all except one believed the IC could observe but should not interfere with the team's assigned tasks.

> *'If I'm a decision maker I'll make the decisions. There's a structure around emergency management, and the discipline that's holding that structure. Don't break it up. Don't contribute it to it coming apart because you want to get involved.'*

> *'That's why the IMT process is pretty cool because it's pretty lean. So yes, that is part of a leader's role. They shouldn't be waiting to get back to the next meeting to find out there are issues'*

> *'if you want to walk in the planning room, sit back and observe, give yourself the confidence that they are thinking it through, so don't go in and take over. Because if you go and take over, they are now going to defer to you and look for your decision and that's not what you are there for.'*

> *'Do not micro-manage. Do not go in and harass the controller, 'what's going on?', you are not going to get any better results by standing over people's shoulders and harassing people and that sort of thing. And in fact you are going to miss things. It's not to say you have to sit in your big chair and, you know, come to the mountain. It's that subtle thing again, the boys have gone off, there's a meeting in an hour, you might just, 'Oh, shit, something's just popped into my head', you go and see the planning guy, 'look Ruth, I've just had a thought, I know you are busy, but you might want to consider that or chase that bit of information, you might want to consider that as well.' There's no problem with that.'*

Leadership - How to reprimand

A topic that has not arisen in previous non-technical skills literature is that of how to reprimand or keep the team on task if they stray. Several participants discussed the skill of doing this without causing additional conflict.

One participant stated that a good IC he worked for *'would take someone outside if he needed to talk to them'* and another spoke of being reprimanded in *'a way that didn't dent our egos I guess. Didn't undermine us at all, but got us back on track.'*

In contrast, some ICs claimed that publicly reprimanding team members has worked well in incidents. One spoke of a time he deliberately *'lost it'* with a mine worker:

> *'I had to pull this guy into line in front of everybody. And actually do it, and I think that actually helped doing it in front of the whole workforce, they saw, 'he*

[the IC] is trying to do the right thing' and I'm not going to be heckled by this one person all the time'.

Another stated:

'And I remember times when I walked in and they hadn't done the work and I said 'get out, 'I'll see you back in here in an hour with the answers.' Right, so when we walked in there, there was a few times there was some complacency or dawdling so 'get out, see you back here in an hour' and let me tell you, don't people get their shit together after that!'

However, he also stated that

'I don't think you need to be aggressive, I think you need to be direct and you need to be consistent. And people need to know what's coming. So I wasn't aggressive as in that I didn't yell at people... If they started to speak shit to me though, that's when I would actually go and start asking very pointed questions and keep going, keep going, keep going so it wasn't aggressive, but it was passive aggressive.'

One participant spoke of the effect a stern and autocratic IC had on those working for him:

'The effect of that IC was that you got your stuff right. By calling the experts and getting every second opinion and asking people to look over this before I take it into him. So his autocrat style created a democratic management environment below him.'

A strategy used by another IC is to *'take them close to the edge but not over the edge'.*

The IC must maintain control of the people and the processes in the IMT meeting, whilst maintaining the team's involvement.

This was said to potentially require the IC to raise his/her voice slightly but not to yell, or to

'have enough authority in his voice, or the way he presents himself, to be able to draw people back to an objective for example'.

Similarly, if the IMT cannot come to a decision the IC

'needs to be authoritative because at the end of the day he needs to make the final call, if, as a team, they can't make a consensus'.

However, one participant seemed confused by this concept and didn't see the arrogance in his statement:

'I usually try to actually bring people around to my point of view through the consultative process.'

Leadership - Remain calm and confident

This element overlaps with the self-confidence element, but is included here because appearing calm and confident on the outside is not necessarily dependant on actually being self-confident. An IC's calm and confident external demeanour was considered important because this influences the perceptions and behaviours of those working for the IC. An apparently calm and confident IC was said to inspire confidence in his team. Similarly, this doesn't mean that team members suddenly become more self-confident individuals, but that they become more confident in the process and become more focussed. Other adjectives used to describe the *'calm under pressure'* IC included: *'rational'*; *'stable'*; *'not have the panic factor'*; *'keeping a cool head'*; *'logical thinking'*; *'the ability to control or manage yourself'*; and always being *'the same and not moody or difficult'*.

> *'One guy I did see in action, when he walked into the management room, he always looked confident, he always looked calm, and you could instantly see a, in the blokes he was, that operated through him. Instantly a calm came over. People seemed a little bit more focussed just looking at how he presented himself.'*

> *'Back at the fire brigade I've seen the ambos do that, do a brilliant job of that. When there's death and destruction everywhere and smoke, blood and guts, and they walk in as casual as you like, cool calm and collected.'*

> *'I've been involved in some pretty horrific fires and fatalities with the fire-brigade, and the senior guys that are really good at, the ones you had confidence in, they seemed to be confident in themselves, they just seemed to, even though the place was collapsing, they didn't seem phased by it. They almost seemed to be, they had their process working really well, they could, they spoke clearly with a firm tone, they just looked like they knew what they were doing even though they might not have, the place was tumbling around their ears but they inspired confidence.'*

> *'I think having gone through it you understand the importance of staying cool, calm and think.'*

> *'I stay calm. I tell myself to stay calm and listen to every word that's being said. Because I don't want to miss any key piece of information. I try to analyse everything I get as quick as I can, you know.'*

> *'He needs, without a doubt, demonstrate control to start with. Because, people are going to look at him and go, 'Oh dear it's bad isn't it', or 'OK, I'm confident'. So I think there is a distinct quality in a person that needs to be able to hold it together I suppose and exude a little bit of confidence when things aren't so great. It's something that people need to be conscious of.'*

It cannot be determined from the current research whether one leadership-style is more or less likely than another to lead to a successful IMT outcome. It could be the case, that in an emergency, a highly authoritarian incident controller may be more successful than a collaborative one if the IC has the necessary technical skills and his team are willing to support him/her. Decisions would no doubt be made quicker, and the issues surrounding collaboration and cooperation would become irrelevant. It is also possible that any conflict that arises may be more honest and short-lived if issues can be sorted out on the spot, even if it involves some shouting or aggression. If this were the case, the IMT may be more likely to progress without the lingering toxic withdrawal and belligerence that was observed in the exercises discussed in Chapter 3. However, this is too simplistic a summary. This research cannot prescribe a preferred leadership style because 'leadership is a process not a person' [87, p. 71]and is equally dependent on the leaders and the followers' perception of the IC and the resulting overall leader-follower relationship [86]. Most of the elements identified in the taxonomy relate to how the IC should observe, speak, act, trust, collaborate with and care for his/her team. Essentially, all the elements in the taxonomy are equally valid for the leader and the team members. The leadership category simply highlights elements that are more commonly associated with leaders. Essentially this research supports the assertion that leadership is not only about the leader but how he/she can engender followership and this is dependent on the team members perception of him and if they are willing to support and work with him/her [31].

6 Discussion

6.1 Decision-making in the mining IMT

This research was inspired by the Pike River Royal Commission recommendation that 'Emergency Management in underground coal mines needs urgent attention' [162, p. 354] and the repeated calls in annual Level 1 emergency exercises to improve mining IMT decision-making. The Level 1 reports have continued to note decision-making deficiencies despite the implementation of structural decision-making processes, such as MEMS and MRAS, suggesting that non-technical issues, which are not addressed by such systems, may impact the IMT decision-making process.

This research has demonstrated the mining IMT decision-making process to be a broad psycho-socio-technical process that encompasses many sub-decisions made during the process of acquiring, communicating and understanding data to develop and maintain situation-awareness as the basis of further decision-making. Consequently, the information gatherers' and decision-makers' reactions to the psychological, physiological and social issues generated by the mining emergency environment become an integral part of the decision-making process because these issues can impact upon how data is acquired, understood and communicated and the resulting IMT situation awareness and decision-making.

Consequently, this research has exposed and refuted the mining industry's assumption that the decision-making process in an IMT is an objective analysis of technical data in pursuit of an optimal choice. This is actually only one small element of mining IMT decision-making solely relevant for decisions of high consequence when all data is available, complete, accurate and not open to multiple interpretations [205]. Such a situation is rarely encountered.

Despite this, the Level 1 reports and many senior mining personnel, claim that the only valid and legitimate decision-making process for the IMT is predefined, rigorous, fully-justifiable, complete, analytical, objective and uses only validated facts. This method of decision-making involves the deliberate rejection of psychological and interpersonal issues that are believed to negatively influence decision-making. However, this deliberate exclusion of intuitive and non-technical issues in the decision-making process may contribute to the poor, delayed or even absent IMT decisions observed in previous exercises and incidents as decision-makers try to over-ride their natural decision-making tendencies in pursuit of the 'legitimate' decision-making process. Wholly analytical decision-making is time consuming, is more susceptible to stress than intuitive methods and is generally most suited to technically inexperienced people who need to work through the details of a problem from the beginning. Furthermore, it is difficult to apply to situations where many inter-related sub-decisions are required (dynamic decision-making)[106]. In complex and highly coupled cases, such as a mining emergency, an analytical solution may not even exist [18] and pursuit of it could lead to confusion and further

delays. It has long been recognised in the psychological literature that the rational choice model is not normative [207] and that in real-life decision-makers are more focused on solving the problem rather than developing options that can be evaluated rationally [228]. Individuals naturally make decisions in a range of ways, from purely intuitive to wholly analytical or a combination of both [2, 135] and from this research it is clear that it is no different in the IMT.

Indeed, despite their assertions that decisions must be objective the interviewees with IMT experience could not explain how they *'just knew what to do'* or *'why a course of action was obvious'*. This difficulty in articulating the cognitive processes they used, and their recollections that the decisions they made were made quickly and responsively, suggests that they have used intuitive decision-making processes during previous incidents.

To ignore the human influence on the information used within the decision-making process is to be blind to the issues that can impact decision-making such as unknowingly basing a decision on incomplete or biased data. Further, to only consider tangible technical information and process it in a structured and technically rigorous manner, potentially discounts the benefits the implicit knowledge a group technically experienced people with varied skills could add to the decision-making process. There is a difference between striving for objectivity in decision-making and isolating it from reality. The mining industry's rhetoric suggests that both are possible and ideal. This research suggests that both are unachievable an undesirable in the mining IMT.

Objectivity in the mining IMT cannot be achieved due to the social process prescribed by MEMS where data is analysed at lower levels and communicated to the IMT at meetings. The drive for objectivity may potentially blind decision-makers to the value that their implicit knowledge, or the intuition of a colleague, based on many years of relevant experience, could add to the decision-making process. It may also mean that the inherently subjective activities they undertake such as trusting others and only checking data that don't match expectations are not recognised.

Whatever decision-making process is used there are two key steps: recognising the situation and taking action. Consequently, there are two key ways decision-making can fail. Either the situation is not recognised or is interpreted wrongly (situation awareness is inaccurate) meaning the chances of making a good decision are slim, or the situation-awareness may be correct but the wrong decision is made. Therefore, non-technical issues have two key opportunities to impact decision-making, either by affecting the development of situation-awareness or by impacting the course of action selected (the decision itself).

The mining IC and IMT, in almost all cases, develop their situation-awareness using information communicated to them in the IMT meeting. Therefore, what information is shared, how information is delivered and how it is discussed can shape their understanding of the situation. Therefore the development of situation-awareness in the IMT is highly dependent on both social and cognitive factors that can impact communication and their ability to process the information. The interaction of many people's construction of the truth, which may or may

not be based on fact, determines the IMT's and IC's situation-awareness. In the mining IMT the development of situation-awareness is particularly important because if the IC's or IMT's situation-awareness is inaccurate, it is generally only by luck that a good decision can be made.

The development of situation awareness also seems highly vulnerable to social and cognitive factors. Many interviewees stated that only if information did not match the IC's expectations would it be validated. Clearly, only checking data that does not fit with pre-conceived ideas is a bias yet this ability to *'probe'* or *'steer'* until the desired information was received was considered a skill required of a good IC rather than a bias. This indicates that despite striving towards objectivity some subjectivity may not be recognised or is selectively accepted.

The reality of decision-making in an IMT is that the information used in the act of decision-making, is influenced by the people involved, consciously or otherwise. Therefore, obtaining true objectivity in the decision-making process is impossible, and rather than naively assuming it occurs, or striving to achieve it, the sources of the inherent subjectivity should be identified and understood. This involves a realistic appraisal of how the environmental, personal and social issues that arise in an IMT, can impact the IC, the IMT members and their teams. This research has begun this search and highlighted several areas for future consideration in the form of a non-technical issues taxonomy. The key issues identified in this research that impact the IMT decision-making process are situation awareness, collaboration and cooperation, trusting others, caring for others, leadership and personal strengths and weaknesses which primarily includes dealing with emotion and stress in oneself and in others resulting from the emergency environment. All of these factors can impact social interaction, which in turn can impact communication, situation-awareness and ultimately the decision.

This research makes the following observations: The mining emergency environment is integral to the IMT decision-making process. The IC's behaviour is critical in determining the level of communication and cooperation in the IMT environment. Communication frequently breaks down due to emotional reactions to interpersonal conflict. A sense that the IC cares for others is essential to engender team-members' best performance. Trust impacts interpersonal behaviours and dictates whether information is accepted or requires validation. It is important to be cognisant of how one's own and others' emotion and how behaviour may be affected by the emergency environment to prevent interpersonal conflict. Low self-confidence may result in behaviour associated with decision-making procrastination. The IC's situation-awareness must extend beyond the situation in the underground mine and encompass the 'big picture' of the emergency management operation.

The emergency environment is a significant component of the decision-making process because it can fundamentally alter the decision-makers physiological and psychological state and how they interact with others. The emergency environment is characterised by confusion, a lack of information and high stress. Aside from the details of the incident, the environment at this time is guided by the people in it, the agencies involved, the social interactions occurring, the level and type of emotion present and appropriate behaviours dictated by the culture of

the industry. The emergency environment is an unfamiliar working environment and dictates that the emotional and physical safety of people becomes the work focus. Unlike other industries, such as healthcare, where the day-to-day goals and emergency goals are generally aligned towards caring for others, this is not the case in mining. Miners who have responded to fatal incidents recognised that the psychological environment of a mining emergency is fundamentally very different from the day-to-day environment and that more, different or better interpersonal skills are required of an IC in this situation than of a mine-manager in daily operations.

The IC's psychological and behavioural reaction to the emergency environment was believed to determine the success of the IMT because this would determine if the team would work with him/her. This research supports the assertions of followership researchers that the leader-follower relationship is a critical part of leadership because *'without followers there can be no leaders'* [31, p. 179]. It is the followers' perception of the leader's attributes such as their perceived confidence, trustworthiness, motivation, personality, loyalty, and the support they provide [87, 86] that dictates whether the team will choose to work with the leader.

In this research most interviewees believed that the skills of a good IC could not be taught and that it was IC's personality that would dictate success or otherwise, possibly due to their difficulty in articulating leadership skills. A key issue raised was the need for the IC to care for the team. This reflects findings from the military where trust and caring are interdependent; the team-members must trust that the incident commander cares for a mutually supportive relationship to develop [10].

In terms of trust, the aspect of leadership that was of particular concern to most of the interviewees was that the mine-manager acting as the IC is legally responsible for both the incident and managing the emergency (in Queensland). If fatalities occur, the IC's performance would be subject to a police inquiry and possibly a criminal investigation. The IC is therefore believed to be working under the burden of assumed guilt during the emergency response and there is significant scepticism that a mine-manager, in the role of an IC, would make decisions based solely on the best interests of the personnel involved. There is a strong belief that the IC would be highly motivated to make decisions that would conceal evidence that could potentially lead to personal repercussions. This inherent mistrust of the leader of the IMT, is not conducive to open and honest communication, collaboration, or efficient decision-making and the increased accountability placed on the IC will undoubtedly lead to increased stress potentially impairing his/her cognitive decision-making abilities.

During previous incidents, where there has been suspicion that the IC's or other team members' first priority is themselves, potentially a result of ego or agenda, valuable energy and time has been wasted analysing the decisions and behaviours of others. A lack of trust, based on fact or intuition, has resulted in complete communication breakdowns and interpersonal and inter-agency conflicts. Primarily this is due to refusals to speak to or cooperate with others who are not trusted. Miners in an IMT would rather work with people with whom trust has already been established. The level of trust has determined the collaboration and cooperation

achieved in and around previous IMTs and individuals or teams trusted before the incident were trusted during incidents despite potential changes to their cognitive states or agendas. Of most interest, was the impact trust seemingly has on an individual's evaluation of the validity of information. If an information provider is trusted, validating this information is generally deemed unnecessary.

Many of the issues identified in the taxonomy are problematic to decision-making due to their impact on social interaction. The common vector is communication; if the information transaction fails it will impact situation-awareness and decision-making. Individuals' reactions to emotion, including stress, and how this manifests in their behaviour can impact social interaction. Existing conflict or personality clashes, from daily interactions, were believed to become exacerbated in the emergency environment. The stress of the situation means that tempers can flare and people can be spoken to in a manner that offends them. This often causes retaliation or withdrawal, resulting in a breakdown of communication. In particular, when the IC is perceived as being dominant, uncaring, not receptive to IMT suggestions, or speaks offensively, people withdraw from discussions in the IMT.

Social issues arise not only at the interpersonal level but also between real and perceived groups, such as the functional groups or external groups arriving to help later in a response. At Pike River the poor interaction between the police and the *'mining people'*, and the factions that developed within the mining people was particularly detrimental to decision-making. This *'us and them'* attitude, highlighted in previous mining literature [82], was also observed at emergency simulations and was highlighted by several interviewees as being problematic.

Many interviewees believed emotion is best dealt with by either controlling it until the work is completed, or if this is impossible, removing the person from the IMT. Emotion was frequently described in terms of being high or low, it was seen as prohibitive to the ability to make 'objective' decisions, and it was primarily understood as a reaction (normally frustration or anger) to interpersonal conflict or personality clashes. However, those with multiple-fatality experience also spoke about emotional issues such as guilt (real or perceived), a fear of the repercussions, a loss of self-confidence, grief, sadness, hopelessness, despondency and frustration. The emotion felt at a mine-site during, or immediately following, a multiple-fatality incident is unlike the emotion experienced in daily operation. The likelihood of losing family members, close mates and colleagues becomes real and the resulting emotion is less likely to be overcome by simply telling oneself, or other IMT members, to control their emotions until after the work is done.

These emotions have the potential to influence decision-making directly or via situation-awareness, but it is not a definite and not easily pre-determined by arbitrarily making calls on who should be removed based on their relationship with the deceased or injured, as was often considered appropriate by interviewees. Given that emotion is the result of how the person-environment relationship is appraised [118], the facts of the situation alone do not automatically dictate the levels of emotion individuals will feel. Furthermore, the existence of emotion does not automatically preclude objective and rational thinking or provide justification to remove

a person whose skills may be highly beneficial to the IMT's decision-making. Individual differences in coping ability, appraisal of the situation and motivations are the factors that will determine if a person can continue in the IMT, this was recognised by few.

A behaviour observed frequently in IMTs, and that may indicate an emotional reaction, is the insatiable desire for more and more information before making a decision. Several interviewees attributed this behaviour to low self-confidence induced by stress. However, it seems equally plausible that a lack of self-confidence could increase stress by artificially lowering their evaluation of their perceived resources (ability) to deal with demands. This behaviour is highlighted here because previously it has been considered to be due to a lack of technical skills, a situation-awareness issue or simply a decision making problem. However, the issue could be a complex emotional reaction based on an individual's evaluation of their own skills, the consequences of making a faulty decision and the appropriate behaviour for the culture of the workplace. For example, not making a decision may actually be a rational choice for some. Short term it has been shown that people feel greater regret over action than inaction [133], therefore taking no action may be more logical choice if trying to prevent regret from potentially making a wrong decision. Several interviewees used the term procrastination, this implies an intention to act [3], but this may not be the case. Some people may have no intention of making a decision. Therefore, requesting more and more information is a rational tactic that meets their own goal of not making a decision, whilst maintaining ego by behaving in a manner that is acceptable within the constraints of the mining culture i.e. it is more respectable for a decision-maker to continue requesting more and more information than to admit he/she is too stressed, fearful or lacks the confidence to make the decision.

Another consideration for the IMT is understanding the emotional needs of those who were working at or near the site of the incident and who often become physically involved in the rescue or body recovery. Several interviewees spoke of breaking down immediately before entering the mine or upon leaving the mine once intensive body recovery activity had stopped. This helped them cope sufficiently to allow them to complete the work required of them. The mine workers at and around the scene of the incident are critical to the success of an IMT because they potentially hold vital information and implement the IMT's decisions. Therefore, consideration of the shock, trauma and critical incident stress these miners experience must be considered by the IMT in terms of how to communicate with them, the tasks they are assigned, how to physically and emotionally support them and how to respect their dignity. Acknowledging that emotion may occur in perfectly rational human-beings may be a first step.

This research has highlighted that the IC in must maintain an awareness of the 'big picture' regarding the overall emergency management operation, not only the technical details of the underground mine. The big picture includes actively maintaining an awareness of the teams and individuals involved in managing the emergency, how they are coping, when they need rest and interaction with other agencies, the media and families. MEMS training considers the IC's interaction with the media but the essential subtleties identified by the experienced

miners and the literature, such as listening for rumours, boosting moral when it fades, and addressing conflict are not addressed. The social awareness required includes an ability to predict potentially problematic interpersonal or intergroup issues before they arise to enable timely intervention. The MEMS process adopts the span-of-control model, which states the IC looks after up to five people, those below him look after five and so on. However, it is clear that the IC actually needs an overall perspective and engagement with the overall strategy and everyone involved. The findings support the assertion of Murphy and Dunn (2012) who identified that the IC must be willing to step out of the hierarchy and communicate with those at lower levels if they request his or her input [141]. However, the viewpoint of some interviewees was that the IC should not leave the IMT room meaning that this cannot be achieved and may reduce the workers' trust in him/her [82].

The isolation of the IMT is symbolic of a view that anything other than factual, tangible and objective data is irrelevant to decision-making. However, through the course of this research it has become apparent that this binary approach to technical versus non-technical, or in the terminology of most of the interviewees, objective versus subjective, may potentially limit the situation-awareness of the IMT and IC. The active suppression of anything that is not considered 'objective' may deny the IMT of vital clues surrounding the incident and may even put more lives at risk. Evidence may not be considered objective simply because of the difficulty in justifying it but this is not a reason to dismiss the information that is available. The summary of the first hour following the explosion at Pike River at the beginning of this thesis supports this assertion, where what was perceived as gut feel and instinct (*"something just didn't feel right"*) was actively suppressed (the electrician who entered the mine rationalizing the missing reflector sticks and signs). At Pike River this delayed activation of the emergency plan for over 40 minutes and in this time more lives were put at risk including the electrician who entered the mine and the senior management who stood at the mine portal chatting without considering the potential for a second blast.

Immediately following an incident the IMT must decide which information to seek out and if biases exist these can seriously influence the direction of the data collection and interpretation of the data potentially leading to poor situation-awareness in the IMT. The information provided to the IMT is rarely complete yet the omissions may be just as significant as the data that is available. The ability to detect what is missing and the potential significance of it is heavily reliant on a mix of technical skills, social skills, mining experience and an ability to undertake complex cognitive functioning at a time when this may naturally be impaired.

It is explicit in the Level 1 reports that the industry expects decisions to be made by following a fully documented process. However, this recommendation may be driven by the understanding that each decision must be documented in sufficient detail to stand up in a court of law, rather than from a genuine intention to improve outcomes. The focus on accountability is likely to add stress [50, 90] and inhibit decision-making by impairing cognitive function and driving people towards a defensive position. For example: *'you've got to ensure the decision has got*

integrity, it's been built up correctly, and protected, and the assumptions have been protected" and *'if there's no integrity, they're the ones that potentially get challenged for being negligent.'*

One participant explicitly stated that incident management should be conducted in exactly the same manner as a post-incident investigation to ensure that any subsequent investigation cannot find any additional information that was not accessed and considered during the incident management. This would undoubtedly mean that no decisions could be made in a useful time-frame. In addition, benefits that could be achieved by using the team's implicit experience and expertise are likely to be lost as individuals become less willing to put their *'balls on the block'*. Some suggested that audio recording pens should be used by all IMT members to ensure the capture of all communication. However, the psychological impact of this must be considered because other interviewees' spoke of adopting behaviours to avoid implicating themselves especially when communication was being recorded or minuted. Their actions included not speaking up in the IMT and working and sharing ideas in groups formed outside of IMTs. Such behaviours undermine the MEMS by rendering the IMT and IC's knowledge incomplete.

Almost all interviewees spoke of the IC needing to have mining experience (a view also expressed by the Pike River Royal Commission). However, the interviewees were also adamant that the decision-making process had to be objective and based on fact. The bulk of the decision making literature would see this as a dichotomy. Analytical decision-making uses only facts. Intuitive methods allow for recognition of the issue and coming up with an action thereby using the decision-maker's experience. Therefore, it seems likely that that a mixture of intuitive and deliberative methods are needed to make a timely decision.

In contrast to the mining industry's stance on striving for objective decision-making, other industries with incident commanders, such as the emergency services, recognise the need for ICs to use intuitive decision making processes at times when the risks are high and a quick decision is required before the situation gets out of hand [106]. Therefore, the mining industry must consider whether the desire for the overt, analytical, well documented and procedural type of decision making is actually improving IMT decision-making.

Currently mining IMTs are trying to adhere to a decision-making process that is ill-defined and bounded by broad criteria such as being objective, documented and analytical. This is bound to cause confusion and delays in the IMT, especially during Level 1 exercises when the focus of the assessors, and by default the participants, is on the process rather than the outcome [119]. A better approach may be to provide IMTs with an understanding of the context in which emergency decisions are made including recognition of the impact of non-technical issues and that different decision-making strategies are valid for different people, situations and types of decisions. Decision-makers could be equipped with knowledge of the advantages and disadvantages associated with different types of decision making methods including a realistic appraisal of the subjectivity within them, the types of decisions they may be called upon to make in a real incident, the biases that may occur and a familiarity with the emergency environment and the collaboration issues that have arisen previously so that these issues are

not unexpected in the event of an incident.

6.2 Contribution to academic knowledge

This thesis has contributed to the body of knowledge in the human factors and emergency management literature. This research is the first study of non-technical issues in the field of managing mining emergencies. It has determined a number of new issues, including trust and caring, that may benefit from non-technical skills training and has expanded on the existing situation awareness, decision-making and communication literature.

The context in which decision-making was explored is unique to the literature in terms of it being conducted by persons inexperienced in the emergency environment, working within the structure of an ICS and managing a coal mine emergency. By way of the findings, this research has highlighted the social and emotive issues that can impact emergency decision-making due to the dependence on communication for situation awareness. Decision-making has been shown to be influenced by the emergency environment and that emergency decision-making incorporates several theoretical decision-making methods such as naturalistic decision-making and dynamic decision-making.

This thesis has expanded knowledge surrounding situation awareness by exploring how it is achieved when people cannot use their senses to understand the situation. The research has shown the vulnerability of achieving situation awareness via communication alone and how the mining emergency environment; where individuals are working in an emotive and unfamiliar work environment, are relatively untrained in the emergency environment and are constrained by the hierarchy of an ICS, can influence situation awareness.

This research has added to the communications literature relating to mining by revealing that communication is more than a transfer of information and that the emotional and social factors that are experienced in a mining emergency can impact the efficiency and accuracy of communication.

This thesis has added to the emergency management literature by exploring the application of an ICS within an industry not experienced or well trained in handling emergencies. The findings support previous researchers' assertions that an ICS is not useful without training, practice and existing personal relationships and expands on this literature be having explored the non-technical skills that support the implementation of an ICS in a mining emergency.

6.3 The way forward

There are several potential ways to address the decision-making problems evident in the industry. Each of these are discussed in turn below. Understanding the limitations and benefits of MEMS is seen as the first step, followed potentially by making some structural changes to MEMS, training could be implemented to address the social and cognitive skills needed to

optimise use of the MEMS, and the Level 1 exercises and reports could be modified to address more of these issues. However, as a priority the Australian coal-mining industry needs to clarify the issues of Police involvement and the legal responsibility during an incident.

6.3.1 The limitations and benefits of MEMS

The issues identified in this research could undermine any benefits potentially gained from the implementation of the MEMS. The MEMS is reliant on good communication and team collaboration to ensure the IC and IMT is provided with timely and accurate information that can be discussed and challenged to facilitate the development of situation-awareness and optimal decision-making. Therefore, interpersonal issues that break down communication and collaboration destroy the integrity of the MEMS by breaking the links between the functional groups and the IMT. The MEMS (without these links) is neither a system nor a reporting structure.

MEMS has been adopted with the expectation that the structure it prescribes can fix the mining IMT's decision-making problems. This is understandable. Mining is procedural and standards driven: there are standard operating procedures; emergency response plans; trigger action response plans; principle hazard management plans; goals to be achieved; objectives to be met; and responsibilities to be assigned. The implementation of the MEMS is simply considered another process. Yet, despite its implementation, and evidence that the problems still exist, the belief that if the process is right then the decision will be right, continues to drive the Level 1 recommendations. However, now they imply that if only the MEMS was better adhered to, the correct decision would automatically result. The perceived validity of a process driven decision is based on the assumption that all decisions are based on technical facts that are independent of the people involved in the process. This seems not to be the case for most, if not all, IMT decisions.

Rather than a process, MEMS is better described as a reporting structure that outlines the roles and responsibilities people are expected to adopt in the event of an emergency. MEMS, by defining each role, facilitates a coordinated and rapid start-up of task-work that is completed in parallel by different teams. This is obviously beneficial. However, alone this is not sufficient to achieve optimum emergency management performance, and is not what the ICS was designed to achieve.

The ICS, on which MEMS is based, does not engender collaboration or cooperation, this was not its purpose. The ICS was designed to build on existing social networks where collaboration and cooperation already existed based on the interpersonal knowledge and trust developed through extensive experience working together in emergency situations [103, 132]. The accounts of ICS failing where these pre-requisites have not been met [215] suggests the MEMS system may only be effective when the necessary pre-requisite social requirements already exist.

In MEMS the IMT meetings provide the opportunity for the teams to coordinate tasks,

develop situation awareness and make decisions. However, these meetings are rarely optimal. The IMT meetings observed were generally a forum for team members to list what they had already done. The success of IMT meetings appears dependent on the environment created by the IC and the level of interpersonal conflict between IMT members. These are supplementary to teamwork factors such as trust and monitoring others as identified in previous research [132].

The isolation of the mining IMT is deliberate feature of MEMS to detach decision-making from any emotion [161]. This means, in comparison to IMTs in other industries, the mining IMT is an odd mix. Like the emergency services they are on-site and make technical and operational decisions, yet unlike the emergency services they are isolated from the incident and cannot use their own senses to understand the problem. The mining IMT, because it develops situation-awareness predominantly through information transmitted by communication from others, is more like a group of senior government officials managing a civilian crisis who remain distant from the activity. Yet, these senior Government officials are only tasked with making high-level strategic decisions and rely on others, on-site, to make operational decisions. This research has shown that the mining IMT is vulnerable to some of the issues that plague command centres during such large scale civilian crises including a lack of situation-awareness [215] and a breakdown of communications [154].

The decision to isolate the mining IMT would be justified if the negative effects of emotion were found to be more debilitating than the benefits gained of interacting with the teams. It is unlikely this has been explored and raises two issues: Firstly isolation is not always possible; Interviewees spoke of senior management being underground at the time of the incident, witnessing the incident, witnessing victims exiting the mine, becoming physically involved and in two cases members of mine management were killed. Secondly; this research has shown that isolating the IMT from the rest of the team does not mean that decision-making is immune to emotion. Many emotions arise within the confines of the isolated IMT that can impact communication, situation awareness and the decision-making processes. It may be better to replace the strategy of trying to eliminate emotion with the development of skills to recognise and deal with the effects emotions may have on decision-making.

The implementation of MEMS in the mining industry fundamentally assumes that the correct people, with the pre-requisite skills, training and experience can be neatly slotted into the roles the system dictates and will perform as required. However, it cannot be guaranteed that the people have been trained in MEMS, that they have emergency experience or that they are the predictable, knowledgeable, stable, calm, confident, logical, agenda-free, social, cooperative and trusting individuals they need to be to make an ICS work. It is the people that make the system, not the organisation chart, and therefore perhaps the system needs to be built around the people and their skills, rather than mould the people to suit the system [205].

Mines generally develop duty-cards to slot into MEMS that clearly define the roles and responsibilities of IMT members and other key roles. These are useful to initiate action [45], but they do not encourage collaboration. Telling people what to do, also tells them what

not to do. Further, it is unlikely that every task, for every role, for every potential incident can be documented prior to it occurring [215, 185]. Over-reliance on procedures in emergency exercises has the potential to raise the status of them to 'hard and fast rules that must be followed blindly' [185, p. 443] and reduce abstract thinking in novel situations [73]. The Level one reports have historically stated that duty-cards should be used as an aide memoir rather than a list to be worked through chronologically, yet this is exactly what has been observed in recent Level 1 exercises.

This research does not suggest that procedures and processes should be abandoned, but simply that there is a need to understand that there are issues that cannot be included in a procedure that can impact decision-making and that potentially the industry may have a false sense of security because written procedures exist [16]. The type of decision-making processes applied in an emergency should be appropriate for the severity of the decisions being made. The blanket use of analytical processes may capture the ideal decision-making process for the re-entry decision, but such processes may be too time consuming and result in delays and confusion if they are used for every decision. Procedures are useful to guide progress, but it is not rational to attribute more worth to issues simply because they were written down pre-incident or to routinely discount anything that was not pre-defined. Speculating and articulating all of the issues (both technical and non-technical) that may impact decision-making in the emergency environment is impossible, a fact that may not be realised by workers if they are trained to use procedures and are assessed on their ability to follow them. Simply, the existence of a good emergency plan does not preclude poor decisions from being made [198].

6.3.2 Suggested changes to the MEMS system

People like MEMS. The feedback from the courses is positive. It makes sense to those who are trained in it and it has improved emergency management performance generally. However, for continued improvement to decision-making, there needs to be an acknowledgement of the social and emotional pre-requisites of a team that is required for the MEMS system to work optimally. There is no evidence that implementing an incident control system alone can optimise decisions, only assertions that such hierarchical structures can impair teamwork and information sharing [210, 4, 105, 175] which are essential to the mining IC's acquisition of situation-awareness. MEMS does not enhance collaboration or cooperation, rather, its focus is on holding one person accountable [215, 178] which has been shown to cause increased conflict and suspicion in IMTs of the past.

Changes to MEMS that may potentially improve performance are listed below:

- The addition of an IMT role solely focussed on the needs of the people who are unaccounted for. People who are unaccounted for often appear to be forgotten. No-one meeting the two men who managed to exit the Pike River mine following the explosion is one real example. Many other examples exist in the Level 1 reports such as the common

lack of urgency in undertaking rescue efforts. A role in the IMT that advocates for the needs of the individuals involved in the incident may help maintain momentum in the IMT and keep the focus on the main goal: keeping those miners alive and doing what can be done to help them escape or be rescued safely. This IMT member can push for the IMT to locate them, identify them, consider the consequences of IMT decisions for them, monitor their rescue or recovery, update the IMT on their status and identify their needs.

- Another addition could be a separate data gathering/intelligence group. This was raised by one interviewee, who noted that the planning group has a significant workload by being responsible for both data gathering and planning. Research from natural disaster crises has recommended improved intelligence be supplied to the planning teams [141], and this research highlights the extensive and on-going nature of data-gathering in an IMT. Further, a separate group may be less prone to biases if their only responsibility is to identify and validate a broad spectrum of potentially relevant information. Some guidance may be required to ensure their information search is neither too wide nor too narrow. It is envisioned that the team leader of this group would be an IMT member and would be responsible for debriefing to ensure that, as a team, all of the intelligence is gathered in the one place and vital debriefing information can be directly reported to the IMT.

- Two roles, the Devil's advocate and the process checker, that have unofficially been adopted by MEMS following Level 1 recommendations have their benefits and drawbacks. The purpose of the Devil's advocate role is to increase deviance in IMT discussions to potentially minimise team convergence biases such as groupthink. However, other industries have had problems with conflict by implementing a Devils advocate role [205]. Therefore, with the apparent frequency and ease with which conflict appears to escalate during mine emergencies care must be taken, by both sides, not to over-react. Mining interviewees during this research criticised people who were overly pedantic in this role, causing frustration and holding up actions. The process checker's role is founded on the assumption that sticking to MEMS will ensure optimal decision. This research highlights that the structure alone is insufficient to ensure this. Therefore, the effectiveness of this role could be enhanced by also 'checking' the important non-technical issues outlined in this thesis.

6.3.3 Training to address the social and cognitive skills that can support MEMS

Future emergency management training must consider the whole decision-making process. This spans from the data gathering stage, through to confirmation of decision action, and includes

the environmental, physiological, psychological, cognitive, inter-agency and interpersonal issues that have been identified as influencing decision-making directly and via situation-awareness. Social issues are important because these appear to be a particularly weak link in the process yet are critical to the acquisition of information and an unbiased evaluation of it. Further, it may be beneficial to train IMT members to recognise when and how they are making decisions, enabling them to evaluate the validity and potential biases that they could bring to the different types of decisions being made.

The critical assumption behind implementing any training is that it will work. However, there is no guarantee that training relating to non-technical issues would improve IMT performance. In aviation, a crew resource management training package was developed to address the non-technical skills required of pilots and has been branded a success, so long as training is delivered regularly to prevent skill decay [93]. However, there are some significant differences between the role of a pilot and the role of a mine-manager that could impact the effectiveness of a training program. Pilots go through extensive personality testing during recruitment to determine their ability to function in an emergency whereas this is not the case for mine-managers. Pilots undergo rigorous and continual emergency training to ensure technical expertise whereas there is no guarantee that a mine-manager will ever experience a Level 1 exercise in their career. Pilots essentially work in a dyad with an equally qualified pilot whereas the IC is responsible for a team of equally inexperienced individuals in the emergency environment with all of the social, physiological and psychological variables this involves. Thus to develop effective training for mining IMTs considerable preparatory work and ongoing research on its effectiveness will be required to justify its implementation. The taxonomy developed in this thesis has gone part way by identifying the key areas that training should address.

Identification of the co-dependence of technical and non-technical skills, for example, in self-confidence, stress, situation-awareness and recognition primed decision making, suggests that training that increases the technical experience of decision-makers would be useful, especially if it is combined with non-technical skills training. Providing potential decision-makers with experience, either through simulations, analysis of case studies or decision games based on true emergency scenarios would increase the number of schemas the decision-makers can draw on when confronted with an emergency scenario. Pattern recognition, such as the acknowledgement that the combined outage of power and communications signifies a serious problem (as was the case at Pike River), can speed up the decision making process by activating some intuitive decision-making processes. These can then be verified using appropriate methods depending on the criticality of the situation. It was evident from the interviews that this tactic has been used by several IMT members in the past. Therefore building understanding around this, including the biases which can unintentionally drive this process, would potentially be more beneficial than prescribing a method that is unintuitive to the decision-makers. Intuition does not mean that technical data are unimportant [138], nor should it replace the rigour and analytical processes that are required for life and death decisions, but a quick intuitive

understanding of the situation is not automatically subjective or invalid simply because it is difficult to justify immediately. It has been proposed recently that individuals identify the issue intuitively and then structure their analytical processing around this to determine if it is indeed true [2, 135] Acknowledgement of the validity of using intuition in certain circumstances has the potential to speed up decision-making and save lives.

6.3.4 Level 1 reports

Level 1 reports are powerful in the industry. Many interviewees quoted from them and the principles they have outlined were generally accepted and respected. The reports clearly shape the issues that the IMTs focus on in the Level 1 emergency exercises as the IMTs generally focus on what they think will be assessed based on previous reports [182]. This means that the limited reporting of cognitive and social issues, potentially because they are difficult to observe, seem too subjective or are considered insulting or irrelevant, contributes to the invisibility of these issues and potentially the perceived irrelevance of them in the wider industry. Conversely, the focus on following procedures, having a process and maintaining objectivity elevates the status of these issues.

Similarly, collaboration and teamworking skills are unlikely to improve as long as the Level 1 exercises continue to be understood as a test rather than a learning opportunity. Currently, the Level 1 reports focus on what is tangible and can be assessed. Issues such as whether a duty-card holder has fulfilled their obligations can easily be determined. Ambiguous tasks such as participating in genuine and fluid collaboration and coordination with colleagues are much less tangible and unlikely to be commented upon in a Level 1 report. The recognition and the associated personal rewards are likely to be greater for sticking to one's own role and completing the tasks assigned to them by their duty card than for taking on un-defined tasks in an effort to collaborate. Consequently, team-members strive to avoid receiving a negative assessment, rather than focusing on the team goal. The fact that mines inspectors act as Level 1 assessors can only exacerbate this issue, and possibly induces a different type of stress to that which may be experienced in a real event [94]. In the words of one interviewee:

> *'We, all of us, want to be stars. Every one of us wants to get 10 out of 10. So you are in this situation, it is a training exercise for you and the rest of the mine to learn. But each and every one of us wants to shine.'*

Given the concerns raised over others' agenda and impending legal inquiries, it seems highly likely that individuals may be even more focussed on their personal accountability in a real-life incident and be even more motivated to minimise their personal risk by sticking rigidly to their own tasks rather than helping others.

The recommendations following the Moura disaster that instigated the development of these exercises have been complied with. However, the spirit of them seems to have been lost within

an overly legislative, fearful, untrusting and sensitive environment. These are issues the industry must address if it is serious about improving IMT decision-making using Level 1 exercises.

6.3.5 Level 1 exercises

Training is only one element of improving performance in IMTs, they need knowledge of the systems, but they also need experience and practice [47]. Simulations are the only ethical method of building experience and providing practice opportunities in the mine-emergency environment. Simulations can be effective if they represent the conditions likely to be experienced in the real situation [54]. However, previous Level 1 exercises have generally only simulated the technical components of an emergency and have focussed on following written procedures. Thus, it cannot be assumed that the current format of Level 1 exercises is adequate to provide the participants with a realistic appreciation of the decision-making difficulties that may be encountered in a real emergency because there has been little success at creating psychological fidelity [1]. A similar issue was identified in the training of offshore installation managers. These managers were assumed to be competent in emergency management following training in simulations. However, this assumption was unfounded and the deaths of 167 individuals due to the Piper Alpha disaster were attributed to the inadequacy of the training and selection of OIMs [76]. A personal inability to cope with making critical decisions and leading others under times of extreme stress was also blamed and since then offshore installation managers have been assessed in terms of their competency to be an IC during an emergency [68].

There is a need for future emergency exercises to increase awareness of the psychological, environmental and social issues that are critical in an emergency. For simulations to be effective, considerable effort will be required to ensure psychological fidelity in the IMT because this is the aspect of the emergency environment that would-be ICs and IMTs are not experts in. Replicating, in simulations, the stress that participants would experience in a real emergency is seen as an essential part of IC training [47, 54]. Realistic simulations require realistic levels of complexity, dynamism and opaqueness [19], time pressure, uncertainty and tension [150] and a feeling of immersion in the situation [1]. The Level 1 exercises have not yet replicated this. Several interviewees spoke highly of a mine emergency simulation that was privately organised and that had attempted to replicate reality by the creation of news bulletins and the arrival of families who needed to be briefed. Those who participated in this seem to have been totally immersed, one interviewee stating *'you're just sick in the guts. And that was just role-playing and I was crook.'* The success of this exercise indicates that it is possible to replicate more psychological fidelity than that which is currently achieved in Level 1 exercises.

The process of feedback and reflection is required for individuals to learn. To enable this, a fair assessment of performance is required. Behavioural marking systems are generally the tool used to assess non-technical skill performance and to determine the effectiveness of any training. Improvement in non-technical skills will only occur when non-technical skills are critiqued to

the same extent that technical skills are. This thesis has gone part way to developing such an assessment tool.

6.3.6 Industry clarification

There are some issues that the Queensland and NSW coal mining industry must address to facilitate improved performance in a future emergency management operation. The most critical is to determine if the police will assume the role of IC in the event of a serious incident at a mine.

It is respectfully acknowledged that the Pike River Royal Commission made the following statements:

> *'In Queensland, the incident controller is the mine-manager'* [162, p. 349]

> *'In both states the police are involved but they do not take control'* [162, p. 349]

> *'The incident controller at an underground coal mining emergency must have mining expertise and, together with the incident management team, must be responsible for coordinating the emergency effort and approving key decisions. This does not prevent a government agency such as the police from being the lead agency or from maintaining its command structure.'* [162, p. 355].

However, the facts are: The police filled the role of IC at the Pike River mine; the Queensland police have the jurisdiction to take control of a situation where lives are at stake and that this authority supersedes the Mining Act; that Queensland Government district or state wide disaster management plans would most probably be activated in the event of a multiple fatality incident at a coal mine [80]; and the police-officer at the 2013 Level 1 exercise stated that if it had been a real incident he would have taken control (personal communication).

The NSW ICCS acknowledges that the severity of some incidents will dictate that the police will have responsibilities under the State Emergency and Rescue Management Act 1989. However, it is unclear precisely how this will fit in with the NSW Mines Rescue ICCS.

Working out how MEMS and ICCS fit within with AIIMS is imperative to create an efficient emergency management process. Maximising performance of multiple agencies requires significant preplanning as indicated by research surrounding recent bushfire events in Australia [154]. Not determining this relationship before the next major incident could seriously impact the IMT's psychological state and their social interaction with other agencies. Pre-determining these relationships could alleviate much of the stress and frustration from what seems an obligatory *'pissing contest'* between those at the mine and external others, including the police, as was the case at Pike River. Furthermore, the stress and responsibilities placed on the mine-manager will be very different depending on the role the police take, therefore, it is critical that

this is established to inform the development of non-technical skills training because different social and cognitive issues and skills may be relevant.

This research also suggests that the Queensland coal-mining industry should consider the impact on emergency management performance resulting from assigning personal responsibility to the mine-manager in the role of IC as per the Mining Health and Safety Act. The mine-manager receives little training or practice in the role of IC in comparison to other industries yet is given more personal responsibility than them. If the mining industry is planning to be reliant on mine-managers as ICs and put them up in court if they fail to act appropriately it is imperative that they are trained and their ability to perform in emergency situations is assessed and used in their selection criteria. Otherwise, other options must be considered. Determining the role of the police may clarify this issue.

Furthermore, the psychological and social impact of this responsibility on the IC and the team must be considered. The fact that the mine-manager is responsible for both the incident and the emergency management played heavily on the minds of interviewees. Several suggested that a specialist and independent IMT, but more often an independent IC, should be called in to make decisions because of concerns the IC would be motivated to make decisions based on self-preservation rather than the best interests of the team. This may be less important if the police take charge, but even if it were an independent team making decisions, its interaction with the police would need to be determined. Further, the industry would need to consider the practical implications of such a strategy including how to train this independent team, how to fund them, how to get them to a mine site quickly enough to be useful, who would take responsibility for the decisions that are critical to the financial future of a mine and the role the mines inspectorate and mines rescue service would play. The social and emotional issues that would affect this team would be very different, they would have the advantage of being less emotionally involved but the team may not *'know'* the mine as well as employees which was deemed essential to forming situation-awareness.

Other suggestions from interviewees include hiring a leadership coach to assist the IC in dealing with the social and management issues that arise during an incident. This role would not necessarily need mining experience, but rather someone who is perceptive and knowledgeable regarding social issues to assist the IC with leadership, collaboration and coordination. Another suggestion was that the mine-manager should not take the IC role but should take a supervisory role where the mine-manager can observe the IMT, the IC and the teams but does not become involved in decision-making unless he or she believes something is wrong. The mine-manager will retain responsibility under the Mining Health and Safety Act whether or not he/she adopts the role of IC so it was believed that by overseeing the operation the mine-manager would better placed to spot deficiencies in the process by maintaining focus on the bigger picture.

The systems used in an emergency should be those that are used on a daily basis. Several interviewees suggested forming IMTs in daily operations to solve smaller incidents to practice working within MEMS. However, for this to be effective, this must include practice of the social

and emotional systems that support MEMS meaning that they may be more intuitive in an emergency. The recent implementation of Associated Non-Technical Skills (ANTS) training in NSW is a step in this direction [38]. Finally, if technical systems are used routinely, such as MRAS to collect data, these will be familiar and up to 70% of the facts will be available at the time of an incident potentially reducing the time needed to gather data [143]. Familiarity with these social, personal and the technical systems, and their interrelatedness, should theoretically lower stress and free up cognitive capacity for making decisions.

6.3.7 Future research

It is suggested that further research would verify the taxonomy presented, identify the non-technical skills that are required to address the issues in the taxonomy, develop training objectives and develop a behavioural marking scheme to be used for feedback purposes and to evaluate the success of any training course.

6.4 Conclusion

This research has explored the non-technical issues that may be responsible for the poor decision-making processes observed during mine emergency exercises and during the Pike River rescue and recovery stage. It has revealed that the mining IMT decision-making process is a complex and highly coupled psycho-socio-technical process as a result of the emergency environment and the implementation of MEMS. Due to the implementation of MEMS, the decision-making process is inherently social and relies on communication.

Decision-making is reliant on having situation-awareness and this situation-awareness is generally achieved via communication with others. This means that the IMT decision-making process is highly vulnerable to the social and emotive aspects of the emergency environment, which are generally unfamiliar to typical mining IMT members and can influence their cognitions, emotions and behaviours. The primary mechanism by which non-technical issues influence decision-making is the influence that they have on communication and consequentially the acquisition and maintenance of team situation awareness.

Acquisition of IMT situation awareness is more complex than using ones own senses to make sense of the environment, the mechanism often assumed in psychological literature, and is much more complex than analysing a set of facts, as is often assumed in the mining industry. Instead, IMT situation awareness is achieved using communication in a process of social interaction, negotiation and continual re-evaluation, in addition to any technical data that is available. Communication is, therefore, critical to the IMT decision-making process.

IMT communication is more than a simple transference of facts during IMT meetings, it includes the sharing of mental-models and understanding the information that is critical to developing IMT situation awareness which is the basis for decision-making. This process of

communicating, developing team situation awareness and making decisions in the IMT is critical to the success of an IMT, yet this research has revealed that maintaining open communication is highly dependent on IMT members controlling their emotive reactions to the emergency situation, their team-mates and other agencies.

This research has presented a decision-making non-technical issues taxonomy that outlines the key issues, as identified by coal miners with emergency experience, that can impact on the IMT decision making process. The taxonomy contains the following categories: developing situation-awareness of the incident and of the emergency management operation; collaboration and cooperation; trusting others; caring for others; personal strengths and weaknesses; maintaining open communication in the IMT; and leadership. This taxonomy is the first step in acknowledging the impact of non-technical issues on mining IMT decision-making and provides the basis for future research in the area.

List of References

[1] L. Alison et al. "Immersive Simulated Learning Environments for Researching Critical Incidents: A Knowledge Synthesis of the Literature and Experiences of Studying High-Risk Strategic Decision Making". In: *Journal of Cognitive Engineering and Decision Making* 7.3 (2013), pp. 255–272.

[2] D. Allen. "Information behavior and decision making in time-constrained practice: A dual-processing perspective". In: *Journal of the American Society for Information Science and Technology* 62.11 (2011), pp. 2165–2181.

[3] C.J. Anderson. "The psychology of doing nothing: forms of decision avoidance result from reason and emotion". In: *Psychological Bulletin* 129.1 (2003), p. 139.

[4] J.R. Anderson. *The architecture of cognition*. Vol. 5. Cambridge, Mass: Harvard University Press, 1983.

[5] A.D. Angie. "The influence of discrete emotions on judgement and decision making: A meta-analytic review." 2008.

[6] H. Artman. "Situation awareness and co-operation within and between hierarchical units in dynamic decision making". In: *Ergonomics* 42.11 (1999), pp. 1404–1417.

[7] J. Ash and C. Smallman. "A case study of decision making in emergencies." In: *Risk Management* 12 (2010), pp. 185–207.

[8] UK Civil Aviation Authority. *Crew resource management training. http://www.caa.co.uk/docs/33/C* 2006.

[9] D.F. Baker. "Enhancing group decision making: An exercise to reduce shared information bias". In: *Journal of Management Education* 34.2 (2010), pp. 249–279.

[10] P.T. Bartone and F.R. Kirkland. "Optimal leadership in small army units". In: *Handbook of Military Psychology*. Ed. by R. Gal and A. D. Mangelsdorff. Chichester, England: John Wiley & Sons, 1991.

[11] C. Bearman, S.B.F. Paletz, and J. Orasanu. "Situational pressures on aviation decision making: Goal seduction and situation aversion". In: *Aviation, Space, and Environmental medicine* 80.6 (2009), pp. 556–560.

[12] C. Bearman et al. "Problems of maintaining effective teamwork during out of scale events". In: *Proceedings of the Bushfire CRC and AFAC 2013 Conference Research Forum*. Vol. 2.

[13] A. Bechara. "The role of emotion in decision-making: Evidence from neurological patients with orbitofrontal damage." In: *Brain and Cognition* 55 (2004), pp. 30–40.

[14] T. Betsch and Andreas Glockner. "Intuition in judgment and decision making: Extensive thinking without effort". In: *Psychological Inquiry* 21.4 (2010), pp. 279–294.

[15] P. Biernacki and D. Waldorf. "Snowball sampling: Problems and techniques of chain referral sampling". In: *Sociological Methods & Research* 10.2 (1981), pp. 141–163.

[16] A. Boin and P. Hart. "Organising for effective emergency management: Lessons from research". In: *Australian Journal of Public Administration* 69.4 (2010), pp. 357–371.

[17] C.A. Bolstad et al. "Modeling shared situation awareness". In: *Proceedings of the 14th Conference on Behavior Representation in Modeling and Simulation (BRIMS), Los Angles, CA*.

[18] B. Brehmer. "Dynamic decision making: Human control of complex systems". In: *Acta Psychologica* 81.3 (1992), pp. 211–241.

[19] B. Brehmer and D. Dorner. "Experiments with computer-simulated microworlds: Escaping both the narrow straits of the laboratory and the deep blue sea of the field study". In: *Computers in Human Behavior* 9.2 (1993), pp. 171–184.

[20] M.J. Brnich Jr and K. M. Kowalski. "Underground Coal Mine Disasters 1900 - 2010: Events, responses, and a Look to the future". In: *Extracting the Science: A Century of Mining Research* (2010), p. 363.

[21] D. Buck, J.E. Trainor, and B.E. Aguirre. "A critical evaluation of the incident command system and NIMS". In: *Journal of Homeland Security and Emergency Management* 3.3 (2006), pp. 1–27.

[22] T. Burgess-Limerick and R. Burgess-Limerick. "Conversational interviews and multiple-case research in psychology". In: *Australian Journal of Psychology* 50.2 (1998), pp. 63–70.

[23] JA. Cannon-Bowers and E. Salas. *Decision making under stress: Implications for individual and team training*. American Psychological Association, Washington, DC. 1998.

[24] P.V.R. de Carvalho, T.H. Benchekroun, and J.O. Gomes. "Analysis of information exchange activities to actualize and validate situation awareness during shift changeovers in nuclear power plants". In: *Human Factors and Ergonomics in Manufacturing & Service Industries* 22.2 (2012), pp. 130–144.

[25] D. Chiappe et al. "A situated approach to shared situation awareness". In: *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*. Vol. 56. Sage Publications, pp. 748–752.

[26] Ministry of Civil Defence and Emergency Management. *The New Zealand coordinated incident management system*. 2005.

[27] S. Clarke and I. Robertson. "A meta-analytic review of the Big Five personality factors and accident involvement in occupational and non-occupational settings". In: *Journal of Occupational and Organizational Psychology* 78.3 (2005), pp. 355–376.

[28] D. Cliff, R. Moreby, and S. Meadowcroft. *Development of a significant incident identification and evaluation system, Australian Coal Association Research Program Project No. C11031*. 2003.

[29] MS. Cohen, JT. Freeman, and BT. Thompson. "Critical thinking skills in tactical decision making: A model and a training method". In: *Decision-Making Under Stress: Implications for Training & Simulation*. Ed. by J. Canon-Bowers and E. Salas. Washington, DC: American Psychological Association Publications, 1998.

[30] H.P. Cole et al. "Decision making during a simulated mine fire escape". In: *IEEE Transactions on Engineering Management* 45.2 (1998), pp. 153–162.

[31] D Collinson. "Rethinking followership: A post-structuralist analysis of follower identities". In: *The Leadership Quarterly* 17.2 (2006), pp. 179–189.

[32] L.K. Comfort. "Crisis management in hindsight: Cognition, communication, coordination, and control." In: *Public Administration Review* Special Issue (2007), pp. 189–197.

[33] R.K. Cooper and A. Sawaf. *Executive EQ: Emotional intelligence in leadership and organizations*. Penguin, 1998.

[34] J. Corbin and A. Strauss. *Basics of qualitative research 3e: Techniques and procedures for developing grounded theory*. Thousand Oaks: Sage, 2008.

[35] G. Coricelli, R.J. Dolan, and A. Sirigu. "Brain, emotion and decision making: the paradigmatic example of regret". In: *Trends in Cognitive Science* 11.6 (2007), p. 258.

[36] A.C. Costa, R. A. Roe, and T. Taillieu. "Trust within teams: The relation with performance effectiveness". In: *European Journal of Work and Organizational Psychology* 10.3 (2001), pp. 225–244.

[37] Industry Skills Council. *RIIERR602D Establish and maintain underground coal mine emergency preparedness and response systems*. 2014.

[38] New South Wales Mine Safety Advisory Council. *Associated Non Technical Skills Action Learning Program*. 2014.

[39] Queensland Parliamentary Counsel. *Coal Mining Safety and Health Regulation*. 2001.

[40] Queensland Parlimentary Counsel. *Coal Mining Safety and Health Act*. 1999.

[41] W.E.D. Creed and Raymond E. Miles. "Trust in organizations: A conceptual framework linking organizational forms, managerial philosophies, and the opportunity costs of controls." In: *Trust in organizations: frontiers of theory and research. Thousand Oaks, CA: Sage*. Ed. by Kramer R. M. and Tyler T. R. 1996, pp. 16–38.

[42] J. Crego and C. Harris. "Training decision making by team based simulation". In: *Incident command: tales from the hot seat*. 2002, pp. 258–269.

[43] M. Crichton and R. Flin. "Training for emergency management: tactical decision games". In: *Journal of Hazardous Materials* 88.23 (2001), pp. 255–266.

[44] M. T. Crichton and R. Flin. "Identifying and training non-technical skills of nuclear emergency response teams". In: *Annals of Nuclear Energy* 31.12 (2004), pp. 1317–1330.

[45] M. T. Crichton, K. Lauche, and R. Flin. "Incident Command Skills in the Management of an Oil Industry Drilling Incident: a Case Study". In: *Journal of Contingencies and Crisis Management* 13.3 (2005), pp. 116–128.

[46] M.T. Crichton. "Improving team effectiveness using tactical decision games". In: *Safety Science* 47.3 (2009), pp. 330–336.

[47] M.T. Crichton, K. Lauche, and R Flin. "Learning from experience: Incident managent team leader training". In: *Naturalistic decision making and macrocognition*. 2008, pp. 103–120.

[48] B. Dearstyne. "The FDNY on 9/11: Information and decision making in crisis". In: *Government Information Quarterly* 24.1 (2007), pp. 29–46.

[49] S. Dekker. "Pilots, controllers and mechanics on trial: Cases, concerns and countermeasures". In: *International Journal of Applied Aviation Studies* 10.1 (2010), pp. 31–49.

[50] S. Dekker. "The criminalization of human error in aviation and healthcare: A review". In: *Safety Science* 49.2 (2011), pp. 121–127.

[51] S.W. A. Dekker. "Accidents are normal and human error does not exist: a new look at the creation of occupational safety". In: *International Journal of Occupational Safety and Ergonomics : JOSE* 9.2 (2003), pp. 211–218.

[52] T.E. Drabek. "The professional emergency manager: Structures and strategies for success". In: *Program on Environment and Behavior Manograph*. Vol. 44. US University of Colorado. Institute of Behavioral Science, 1987.

[53] J.W. Driscoll. "Trust and participation in organizational decision making as predictors of satisfaction". In: *Academy of Management Journal* 21.1 (1978), pp. 44–56.

[54] J.E. Driskell and J. H. Johnston. "Stress exposure training". In: *Making decisions under stress: implications for individual and team training*. Ed. by Janis A. Cannon-Bowers and Eduardo Salas. Washington, DC U6 - ctx$_v$er = Z39.88 − 2004&ctx$_e$nc = infoU7 − eBookU8 − FETCH − uq$_c$atalog$_b$302708321: American Psychological Association, 1998.

[55] J.E. Driskell and E. Salas. *Stress and human performance*. New Jersey: Laurence Erlbaum Associates, 1996.

[56] J.R. Dunn and M.E. Schweitzer. "Feeling and believing: the influence of emotion on trust". In: *Journal of Personality and Social Psychology* 88.5 (2005), p. 736.

[57] F.T. Durso and A. Sethumadhavan. "Situation awareness: Understanding dynamic environments". In: *Human Factors* 50.3 (2008), pp. 442–448.

[58] A.C. Edmondson. "Speaking up in the operating room: How team leaders promote learning in interdisciplinary action teams". In: *Journal of Management Studies* 40.6 (2003), pp. 1419–1452.

[59] M.R. Endsley. "Situation awareness global assessment technique (SAGAT)". In: *Aerospace and Electronics Conference, 1988. NAECON 1988., Proceedings of the IEEE 1988 National*. IEEE, pp. 789–795.

[60] M.R. Endsley. "Toward a theory of situation awareness in dynamic systems." In: *Human Factors.* 37.1 (1995), pp. 32–64.

[61] M.R. Endsley and D.J. Garland. *Situation awareness analysis and measurement*. CRC Press, 2000.

[62] E.E. Entin and D. Serfaty. "Adaptive team coordination". In: *Human Factors: The Journal of the Human Factors and Ergonomics Society* 41.2 (1999), pp. 312–325.

[63] D. Evans. "Problems in the decision making process: a review". In: *Intensive Care Nursing* 6.4 (1990), pp. 179–184.

[64] F.E. Fiedler. *A theory of leadership effectiveness*. New York: McGraw-Hill, 1967.

[65] Australasian Fire and Emergency Services Authorities Council. *Australasian inter-service incident managenment system: A management system for any emergency*. Third. Australasian Fire and Emergency Services Authorities Council, 2011.

[66] G. Fletcher et al. "Rating non-technical skills: Developing a behavioural marker system for use in anaesthesia." In: *Cognition Technology and Work* (6) (2004), pp. 165–171.

[67] R. Flin. *Decision making under stress: emerging themes and applications*. Aldershot: Ashgate, 1997.

[68] R. Flin. *Sitting in the hot seat: Leaders and teams for critical incident management*. Chichester: Wiley, 1996.

[69] R. Flin and A. Arbuthnot. "Lessons from the hot seat". In: *Incident Command: Tales from the Hot Seat, Aldershot, UK: Ashgate* (2002).

[70] R. Flin and K. Arbuthnot. *Incident command: tales from the hot seat*. Aldershot: Ashgate, 2002.

[71] R. Flin and N. Maran. "Identifying and training non-technical skills for teams in acute medicine". In: *Quality and Safety in Health Care* 13.(Suppl 1) (2004), pp. i80–i84.

[72] R. Flin and L. Martin. "Behavioral markers for crew resource management: A review of current practice". In: *The International Journal of Aviation Psychology* 11.1 (2001), pp. 95–118.

[73] R. Flin, P. O'Connor, and M. Crichton. *Safety at the sharp end*. Aldershot: Ashgate, 2008.

[74] R. Flin and G. Slaven. "Personality and emergency command ability". In: *Disaster Prevention and Management* 5.1 (1996), pp. 40–46.

[75] R. Flin and G. Slaven. *The selection and training of offshore installation managers for crisis management*. HM Stationery Office, 1994.

[76] R. Flin and G.M. Slaven. "Identifying the right stuff: Selecting and training on-scene emergency commanders." In: *Journal of Contingencies and Crisis Management* 3.2 (1995), pp. 113–123.

[77] R. Flin et al. *Crew Resource Management for Offshore Teams: Lessons from Aviation*. 1998.

[78] J. Freeman, M.S. Cohen, and BT Thompson. "Time-stressed decision-making in the cockpit". In: *Proceedings of the Association for Information Systems*.

[79] N. Friedland and G. Keinan. "The effects of stress, ambiguity tolerance, and trait anxiety on the formation of causal relationships". In: *Journal of Research in Personality* 25 (1991), pp. 88–107.

[80] Queensland Goverment. *Disaster Management Act*. 2003.

[81] Queensland Government. *Recognised Standard 08; Conduct of mine emergency exercises*. 2009.

[82] N. Gunningham and D. Sinclair. "Trust and Safety in the Coal Mining Sector". In: *ACARP Project Number: C16026*. Gunningham and Associates, 2008.

[83] D.K. Harrington and JE Kello. "Systematic evaluation of nuclear operator team skills training: a progress report". In: IEEE, pp. 370–373.

[84] R.L. Helmreich. "Cockpit management attitudes". In: *Human Factors: The Journal of the Human Factors and Ergonomics Society* 26.5 (1984), pp. 583–589.

[85] R.L. Helmreich. “Culture and error in space: Implications from analog environments”. In: *Aviation Space and Environmental Medicine* 71.9; PART 2 (2000), A133–A139.

[86] E.P. Hollander. “Leadership, followership, self and others”. In: *The Leadership Quarterly* 3.1 (1992), pp. 43–54.

[87] E.P. Hollander. “The essential interdependence of leadership and followership”. In: *Current Directions in Psychological Science* (1992), pp. 71–75.

[88] Hassan I.N. and D. Allen. “Information sharing and trust during major incidents: Findings from the oil industry”. In: *Journal of the American Society for Information Science and Technology* 63.10 (2012), pp. 1916–1928.

[89] I.L. Janis and L. Mann. “Coping with decisional conflict: An analysis of how stress affects decision-making suggests interventions to improve the process”. In: *American Scientist* (1976), pp. 657–667.

[90] I.L. Janis and L. Mann. “Emergency decision making: A theoretical analysis of responses to disaster warnings”. In: *Journal of Human Stress* 3.2 (1977), pp. 35–48.

[91] G.L. Kaempf et al. “Decision making in complex naval command-and-control environments”. In: *Human Factors: The Journal of the Human Factors and Ergonomics Society* 38.2 (1996), pp. 220–231.

[92] B.G. Kanki. “Communication and crew resource management”. In: *Crew resource management*. Elsevier, 2010, pp. 99–136.

[93] B.K. Kanki, Helmreich R.L., and J. Anca. *Crew Resource Management*. Second Edition. San Diego: Academic Press, 2010.

[94] K.S. Kassam, K. Koslov, and W.B. Mendes. “Decisions under distress: Stress profiles influence anchoring and adjustment”. In: *Psychological Science* 20.11 (2009), pp. 1394–1399.

[95] G. Keinan. “Decision making under stress: scanning of alternatives under controllable and uncontrollable threats”. In: *Journal of personality and social psychology* 52.3 (1987), pp. 639–644.

[96] G. Keinan and N. Friedland. “Decision making under stress: Scanning of alternatives under physical threat”. In: *Acta Psychology* 64 (1987), pp. 219–228.

[97] G. Keinan et al. “The effect of stress on the suppression of erroneous competing responses”. In: *Anxiety, Stress and Coping* 12.4 (1999), pp. 455–476.

[98] D.M. Kennedy and S.A. McComb. “Merging internal and external processes: Examining the mental model convergence process through team communication”. In: *Theoretical Issues in Ergonomics Science* 11.4 (2010), pp. 340–358.

[99] J. Keyton, S.J. Beck, and M. B. Asbury. “Macrocognition: a communication perspective”. In: *Theoretical Issues in Ergonomics Science* 11.4 (2010), pp. 272–286.

[100] A. Kirlik and R. Strauss. "Situation awareness as judgment I: Statistical modeling and quantitative measurement". In: *International Journal of Industrial Ergonomics* 36.5 (2006), pp. 463–474.

[101] G. Klein. "Analysis of Situation Awareness from Critical Incident Reports". In: *Situation awareness analysis and measurement*. Ed. by M.R. Endsley and D.J. Garland. New Jersey: Lawrence Erlbaum Associates, 2000.

[102] G. Klein. "Naturalistic decision making". In: *Human Factors: The Journal of the Human Factors and Ergonomics Society* 50.3 (2008), p. 456.

[103] G. Klein. *Sources of power : how people make decisions / Gary Klein*. Cambridge: MIT Press, 1999.

[104] G. Klein, R. Calderwood, and A. Clinton-Cirocco. *Rapid decision making on the fire ground (ARI Technical report 796)*. U.S. Army Research Institute for the Behavioral and Social Sciences, 1988.

[105] G. Klein, S. Wiggins, and C.O. Dominguez. "Team sensemaking". In: *Theoretical Issues in Ergonomics Science* 11.4 (2010), pp. 304–320.

[106] G.A. Klein. *A recognition-primed decision (RPD) model of rapid decision making*. Ablex Publishing Corporation, 1993.

[107] T. Kontogiannis. "Stress and operator decision making in coping with emergencies". In: *International Journal of Human-Computer Studies* 45 (1996), pp. 75–104.

[108] T. Kontogiannis and Z. Kossiavelou. "Stress and team performance: principles and challenges for intelligent decision aids". In: *Safety Science* 33.3 (1999), pp. 103–128.

[109] K.M. Kowalski. "A human component to consider in your emergency management plans: the critical incident stress factor". In: *Safety Science* 20.1 (1995), pp. 115–123.

[110] K.M. Kowalski. "A Missing Component In Your Emergency Management Plans: The Critical Incident Stress Factor". In: *Retrieved May* 28 (2011).

[111] K.M. Kowalski-Trakofler and C. Vaught. "Psycho-Social Issues in Mine Emergencies: The Impact on the Individual, the Organization and the Community". In: *Minerals* 2.2 (2012), pp. 129–168.

[112] K.M. Kowalski-Trakofler, C. Vaught, and T. Scharf. "Judgment and decision making under stress: an overview for emergency managers". In: *International Journal of Emergency Management* 1.3 (2003), pp. 278–289.

[113] K.M. Kowalski-Trakofler et al. "A Study of First Moments in Underground Mine Emergency Response". In: *Journal of Homeland Security and Emergency Management* 7.1 (2010).

[114] G. Lakomski and C.W. Evers. "Passionate rationalism: the role of emotion in decision making." In: *Journal of Educational Administration* 48.4 (2010), pp. 438–450.

[115] J Larken. "The command requirement and OIM qualification". In: *First Offshore Installation Management Conference: Emergency Command Responsibilities, The Robert Gordon University, Aberdeen*.

[116] R.P. Larsen. "Decision making by military students under severe stress". In: *Military Psychology* 13.2 (2001), pp. 89–98.

[117] G. Larsson et al. "Leadership under severe stress: A grounded theory study". In: *Concepts for Air Force leadership*. Ed. by R. Lester & A. G. Morton. Maxwell, AL: Air University., 2001, 441447.

[118] R.S. Lazarus. *Stress and emotion: A new synthesis*. Springer Publishing Company, 2006.

[119] J.S. Lerner and P.E. Tetlock. "Accounting for the effects of accountability". In: *Psychological Bulletin* 125.2 (1999), p. 255.

[120] B. Limerick, T. Burgess-Limerick, and M. Grace. "The politics of interviewing: power relations and accepting the gift". In: *International Journal of Qualitative Studies in Education* 9.4 (1996), pp. 449–460.

[121] R. Lipshitz. "Converging themes in the study of decision making in realistic settings". In: *Decision making in action: Models and methods*. Ed. by G.A. Klein et al. Westport, CT, US: Ablex Publishing, 1993, p. 480.

[122] R. Lipshitz. "Rigor and relevance in NDM: how to study decision making rigorously with small Ns and without controls and (inferential) statistics". In: *Journal of Cognitive Engineering and Decision Making* 4.2 (2010), pp. 99–112.

[123] A. Litt et al. "Pressure and perverse flights to familiarity". In: *Psychological Science* 22 (2001).

[124] G. Loewenstein and J.S. Lerner. "The role of affect in decision making". In: *Handbook of affective science* 619.642 (2003), p. 3.

[125] L.D. Lutz and M.K. Lindell. "Incident command system as a response model within emergency operation centers during Hurricane Rita". In: *Journal of Contingencies and Crisis Management* 16.3 (2008), pp. 122–134.

[126] L. Mallett, M. J. Brnich Jr, and C. Vaught. "Training to Improve Emergency Communication Skills. http://www.cdc.gov/niosh/mining/UserFiles/works/pdfs/tiems.pdf". In: ().

[127] L. Mallett, C. Vaught, and M. Brnich. "The emergency communication triangle". In: *National Institute for Occupational Safety and Health: Pittsburgh, PA, USA* (1999).

[128] L. Mallett, C. Vaught, and M.J. Brnich Jr. "Sociotechnical communication in an underground mine fire: A study of warning messages during an emergency evacuation". In: *Safety Science* 16.5-6 (1993), pp. 709–728.

[129] K. A. May. “Interview techniques in qualitative research: Concerns and challenges.” In: *Qualitative nursing research: A contemporary dialogue*. Ed. by In J. M. Morse (Ed.) Thousand Oaks, CA, US: Sage Publications, Inc., 1991, pp. 188–201.

[130] McAteer and Associates. *The SAGO mine disaster: A preliminary report to Governor Joe Manchin.* 2006.

[131] P. McHugh. *Defining the situation: the organization of meaning in social interaction.* Indianapolis: Bobbs-Merrill, 1968.

[132] J. McLennan et al. “Decision making effectiveness in wildfire incident management teams”. In: *Journal of Contingencies and Crisis Management* 14.1 (2006), pp. 27–37.

[133] B.A. Mellers, A. Schwartz, and A.D.J. Cooke. “Judgment and decision making”. In: *Annual Review of Psychology* 49 (1998), pp. 447–477.

[134] D. Meyerson, K.E. Weick, and R.M. Kramer. “Swift trust and temporary groups”. In: *Trust in organizations: Frontiers of theory and research* (1996), p. 195.

[135] J.A. Mikels et al. “Should I go with my gut? Investigating the benefits of emotion-focused decision making”. In: *Emotion* Advance online publication. doi: 10.1037/a0023986 (2011).

[136] S. Mishra. “Manipulation and Emotion in Decision Making: A psychological analysis”. In: *Social Science International* 23.1 (2007), pp. 90–101.

[137] D. G.V. Mitchell. “The nexus between decision making and emotion regulation: A review of convergent neurocognitive substrates”. In: *Behavioural Brain Research* 217 (2011), pp. 215–231.

[138] K.L Mosier. “Technology and naturalistic decision making: Myths and realities”. In: *Naturalistic decision making and macrocognition*. 2008, pp. 41–56.

[139] K.L. Mosier and U. Fischer. “The role of affect in naturalistic decision making”. In: *Journal of Cognitive Engineering and Decision Making* 4.3 (2010), pp. 240–255.

[140] K.L. Mosier and U.M. Fischer. “Does affect matter in naturalistic decision making?” In: *Naturalistic decision making and computers*. Ed. by B.L.W. Wong and A. Stanton N. BCS.

[141] P. Murphy and P. Dunn. “Senior leadership in times of crisis”. In: *Noetic Notes* 3.1 (2012).

[142] O. Njo and E. L. Rake. “A discussion of decision making applied in incident command”. In: *International Journal of Emergency Management* 6.1 (2009), pp. 55–72.

[143] G. Nugent et al. *Emergency response: Mine entry data management, Australian Coal Association Research Program Project No. C19010*. 2011.

[144] G. Nugent et al. “Mines rescue guidelines: the next generation.” In: *10th Underground Coal Operators’ Conference,(Eds., Aziz, N and Nemcik, J),University of Wollongong and the Australasian Institute of Mining and Metallurgy, 2010, pp288-298* (2010).

[145] G. Nugent et al. “Pike River mine re-entry and emergency mine re-entry guidelines application and learning.” In: *Australian Coal Operators Conference*.

[146] P. O’Connor and R. Flin. “Crew Resource Management training for offshore oil production teams”. In: *Safety Science* 41.7 (2003), pp. 591–609.

[147] P. O’Connor et al. “Identifying the team skills required by nuclear power plant operations personnel”. In: *International Journal of Industrial Ergonomics* 38.11-12 (2008), pp. 1028–1037.

[148] J. Orasanu. “Crew collaboration in space: A naturalistic decision-making perspective”. In: *Aviation, Space, and Environmental Medicine* 76.Supplement 1 (2005), B154–B163.

[149] J. Orasanu. “Training for aviation decision making: The naturalistic decision making perspective”. In: *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*. Vol. 39. SAGE Publications, pp. 1258–1262.

[150] J. Orasanu and T. Connolly. “The reinvention of decision making”. In: *Decision making in action: Models and methods. ,* ed. by G.A. Klein et al. Westport, CT, US: Ablex Publishing, 1993, pp3–20.

[151] J. Orasanu, R.K. Dismukes, and U. Fischer. “Decision errors in the cockpit”. In: *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*. Vol. 37. SAGE Publications, pp. 363–367.

[152] J. Orasanu and U. Fischer. “Finding decisions in natural environments: The view from the cockpit”. In: *Naturalistic Decision Making* (1997), pp. 343–357.

[153] J.M. Orasanu. “Flight crew decision-making”. In: *Crew Resource Management*. Ed. by B.K. Kanki, Helmreich R.L., and J. Anca. San Diego: Academic Press, 2010, pp. 147–179.

[154] C. Owen et al. *Organising For Effective Incident Management*. Bushfire CRC, Australia, 2014.

[155] Douglas P. and R. Flin. “Disaster stress: an emergency management perspective”. In: *Disaster Prevention and Management* 8.4 (1999), pp. 261–267.

[156] S.H. Parker et al. “Surgeons’ leadership in the operating room: an observational study”. In: *The American Journal of Surgery* 204.3 (2012), pp. 347–354.

[157] A. Parush et al. “Communication and team situation awareness in the OR: Implications for augmentative information display”. In: *Journal of Biomedical Informatics* 44.3 (2011), pp. 477–485.

[158] D. Paton. “Stress in disaster response:A risk management approach”. In: *Disaster Prevention and Management* 12.3 (2003).

[159] M.Q. Patton. *Qualitative research*. Wiley Online Library, 2005.

[160] M.S. Pfaff and M.D. McNeese. "Effects of mood and stress on distributed team cognition". In: *Theoretical Issues in Ergonomics Science* 11.4 (2010), pp. 321–339.

[161] Royal Commission on the Pike River Coal Mine Tragedy. *Royal Commission on the Pike River Coal Mine Tragedy: Volume 1 and Overview*. 2012.

[162] Royal Commission on the Pike River Coal Mine Tragedy. *Royal Commission on the Pike River Coal Mine Tragedy: Volume 2*. 2012.

[163] L.R. Pondy. "Leadership is a language game". In: *Readings in Managerial Psychology* (1989), p. 224.

[164] C.L. Porath and A. Erez. "Does rudeness really matter? The effects of rudeness on task performance and helpfulness". In: *Academy of Management Journal* 50.5 (2007), pp. 1181–1197.

[165] S.D. Preston et al. "Effects of anticipatory stress on decision making in a gambling task." In: *Behavioral Neuroscience* 121.2 (2007), pp. 257–263.

[166] M. C. Price and E. Norman. "Intuitive decisions on the fringes of consciousness: Are they conscious and does it matter?" In: *Judgement and Decision Making* 3.1 (2008), pp. 28–41.

[167] M. Rahman. "Understanding naturalistic decision making under life threatening conditions". In: *Naturalistic decision making and computers*. Ed. by B.L.W. Wong and A. Stanton N. BCS.

[168] T. Reader et al. "Non-technical skills in the intensive care unit". In: *British Journal of Anaesthesia* 96.5 (2006), pp. 551–559.

[169] Coal Services NSW Mines Rescue. *Mines Rescue Incident Control and Command System (ICCS) Guide*. 2014.

[170] J.S. Rijnbout and B.M. McKimmie. "Deviance in organizational group decision making: The role of information processing, confidence, and elaboration". In: *Group Processes & Intergroup Relations* (2012), p. 1368430212447136.

[171] E. W. M. Rondeel. "The influence of stress and mood on decision making in critical situations. To what extent can we predict human performance?" In: *Revue d Intelligence Artificielle* 23.4 (2009), pp. 449–466.

[172] E. Salas, D.E. Sims, and C S. Burke. "Is there a Big Five in teamwork?" In: *Small group research* 36.5 (2005), pp. 555–599.

[173] E. Salas et al. "Toward an understanding of team performance and training". In: *Teams. Their Training and Performance*. Ed. by R. Swezey and E. Salas. New York: Ablex, 1992, pp. 3–29.

[174] A.M. Schaafstal, J.H. Johnston, and R.L. Oser. "Training teams for emergency management". In: *Computers in Human Behavior* 17.5 (2001), pp. 615–626.

[175] J.M. Schraagen and M.H. Veld. “Information Sharing During Crisis Management in Hierarchical vs. Network Teams”. In: *Journal of Contingencies and Crisis Management* 18.2 (2010), pp. 117–127.

[176] N. Schwarz. “Emotion, cognition, and decision making.” In: *Cognition and Emotion* 14.4 (2000), pp. 433–440.

[177] H. Selye. *The stress of life*. New York, NY, USA: McGraw-Hill, 1956.

[178] Queensland Mines Rescue Service. *MEMS Course Guide*. 2009.

[179] D.R. Shanks, D.A. Lagnado, and B.R. Newell. *Straight choices: the psychology of decision making*. Hove, East Sussex: Psychology Press, 2007.

[180] B. Sharma et al. “Non-technical skills assessment in surgery.” In: *Surgical oncology* 20.3 (2011), pp. 169–177.

[181] B. Shiv, G. Loewenstein, and A. Bechara. “The dark side of emotion in decision-making: When individuals with decreased emotional reactions make more advantageous decisions.” In: *Cognitive Brain Research* 23 (2005), pp. 85–92.

[182] K. Siegel-Jacobs and J. F. Yates. “Effects of procedural and outcome accountability on judgment quality”. In: *Organizational Behavior and Human Decision Processes* 65.1 (1996), pp. 1–17.

[183] M. Sjoberg, C. Wallenius, and G. Larsson. “Leadership in complex, stressful rescue operations: a qualitative study”. In: *Disaster Prevention and Management,* 15.4 (2006), pp. 576–584.

[184] M. Sjoberg, C. Wallenius, and G. Larsson. “Leadership in complex, stressful rescue operations: A quantitative test of a qualitatively developed model”. In: *Disaster Prevention and Management,* 20.2 (2011), pp. 199–212.

[185] J. Skriver and R. Flin. *Decision Making in Offshore Emergencies: Are Standard Operating Procedures the Solution?* 1996.

[186] J. Skriver, L. Martin, and R. Flin. “Emergency decision making”. In: *Psychological investigations of competence in decision making*. 2004, p. 124.

[187] G. Slaven and R. Flin. “Selecting managers for a hazardous environment”. In: *Disaster Prevention and Management* 6.5 (1997), pp. 336–342.

[188] G. Slaven and R. Flin. “Selecting managers for a hazardous environment”. In: *Disaster Prevention and Management* 6.5 (1997), pp. 336–342.

[189] G. Slaven and R. Flin. “Selecting Managers for a Hazardous Environment: Offshore Petroleum Installations”. In: *Personnel Review* 23.5 (1994), pp. 4–14.

[190] K. Smith and P.A. Hancock. “Situation awareness is adaptive, externally directed consciousness”. In: *Human Factors: The Journal of the Human Factors and Ergonomics Society* 37.1 (1995), pp. 137–148.

[191] A. Sneddon, K. Mearns, and R. Flin. "Stress, fatigue, situation awareness and safety in offshore drilling crews". In: *Safety Science* 56 (2013), pp. 80–88.

[192] A.A. Stachowski, S.A. Kaplan, and M.J. Waller. "The benefits of flexible team interaction during crises". In: *Journal of Applied Psychology* 94.6 (2009), p. 1536.

[193] N. Stanton. "An introduction to military teams". In: *Trust in Military Teams*. Ashgate Publishing, Ltd., 2011.

[194] N.A. Stanton et al. "Genotype and phenotype schemata and their role in distributed situation awareness in collaborative systems". In: *Theoretical Issues in Ergonomics Science* 10.1 (2009), pp. 43–68.

[195] N.A. Stanton et al. "Genotype and phenotype schemata as models of situation awareness in dynamic command and control teams". In: *International Journal of Industrial Ergonomics* 39.3 (2009), pp. 480–489.

[196] N.A. Stanton et al. "Is situation awareness all in the mind?" In: *Theoretical Issues in Ergonomics Science* 11.1-2 (2010), pp. 29–40.

[197] A. Steadman. "Neuroscience for combat leaders: A brain-based approach to leading on the modern battlefield". In: *Military Review* 91.3 (2011), p. 50.

[198] S. Stephan. "Decision-making in incident control teams". In: *Journal of Occupational Health and Safety Australia and New Zealand* 17.2 (2001), pp. 135–146.

[199] A.F. Stokes, K. Kemper, and K. Kite. "Aeronautical decision making, cue recognition, and expertise under time pressure". In: *Naturalistic Decision Making* (1997), pp. 183–196.

[200] K.G. Stricklin. *Coal mine safety and health report of investigation: Underground Coal Mine Fatal Underground Coal Burst Accidents August 6 and 16, 2007. Crandall Canyon Mine, Genwal Resources Inc.* 2007.

[201] K. Sulistyawati, C.D. Wickens, and Y.P. Chui. "Prediction in situation awareness: Confidence bias and underlying cognitive abilities". In: *The International Journal of Aviation Psychology* 21.2 (2011), pp. 153–174.

[202] Mine Safety Technology and Training Commission. *Improving mine safety technology and training: Establishing U.S. global leadership*. 2006.

[203] *Transcript of phase two hearing held on 12 September 2011 at Greymouth*. 2011.

[204] *Transcript of phase two hearing held on 13 September 2011 at Greymouth*. 2011.

[205] S. Tuler. "Individual, group, and organizational decision making in technological emergencies: A review of research". In: *Organization & Environment* 2.2 (1988), pp. 109–138.

[206] A. Tversky and D. Kahneman. “Judgment under uncertainty: Heuristics and biases”. In: *Science* 185 (1974), pp. 1124–1131.

[207] A. Tversky and D. Kahneman. “Rational choice and the framing of decisions”. In: *Journal of Business* (1986), S251–S278.

[208] S. Uitdewilligen, M.J. Waller, and F.R.H. Zijlstra. “Team cognition and adaptability in dynamic settings: A Review of Pertinent Work”. In: *International Review of Industrial and Organizational Psychology* 25 (2010), p. 293.

[209] J.E. Urosek and K.S. Diederich. *Directing responses to mine fires and explosions*. 2008.

[210] W. Van Santen, C. Jonker, and N. Wijngaards. “Crisis decision making through a shared integrative negotiation mental model”. In: *International Journal of Emergency Management* 6.3 (2009), pp. 342–355.

[211] C. Vaught, M.J. Brnich, and L.G. Mallett. *An oral history analysis of mine emergency response*. Vol. DHHS (NIOSH) Publication No. 2004-145, IC 9471, 2004 Apr:1-77. U.S. Department of Health et al., 2004.

[212] C. Vaught et al. *Behavioral and organizational dimensions of underground mine fires*. US Department of Health et al., 2000.

[213] B. Van de Walle and M. Turoff. “Decision support for emergency situations”. In: *Information Systems and E-Business Management* 6.3 (2008), pp. 295–316.

[214] D.J. Ward et al. “Using framework analysis in nursing research: a worked example”. In: *Journal of Advanced Nursing* 69.11 (2013), pp. 2423–2431.

[215] W.L. Waugh and G. Streib. “Collaboration and leadership for effective emergency management”. In: *Public Administration Review* 66 (2006), pp. 131–140.

[216] T. Wehner, C. Clases, and R. Bachmann. “Co-operation at work: a process-oriented perspective on joint activity in inter-organizational relations”. In: *Ergonomics* 43.7 (2000), pp. 983–997.

[217] K.E. Weick. *Sensemaking in organisations*. London: SAGE, 1995.

[218] K.E. Weick. “The Collapse of Sensemaking in Organizations: The Mann Gulch Disaster”. In: *Administrative Science Quarterly* 38.4 (1993), pp. 628–652.

[219] C.D. Wickens. “The trade-off of design for routine and unexpected performance: Implications of situation awareness”. In: *Situation Awareness Analysis and Measurement* (2000), pp. 211–225.

[220] E.L. Wiener, B.G. Kanki, and R.L. Helmreich. *Cockpit resource management*. Gulf Professional Publishing, 1993.

[221] J. Wiersma. “The press release: Symbolic communication in life history interviewing.” In: *Journal of Personality and Social Psychology* 56.1 (1988), pp. 205–238.

[222] F. W. Windridge et al. *Report on an accident at Moura No. 2 Underground Mine on Saturday, 7 August, 1994: Wardens Inquiry.* 1996.

[223] N. Wran and J. McClelland. *NSW mines safety review: Report to the Hon Kerry Hickey MP Minister for Resources.* 2005.

[224] S. Yule et al. "Development of a rating system for surgeons' non-technical skills". In: *Medical Education* 40.11 (2006), pp. 1098–1104.

[225] S. Yule et al. "Experience matters: comparing novice and expert ratings of non-technical skills using the NOTSS system". In: *ANZ Journal of Surgery* 79.3 (2009), pp. 154–160.

[226] S. Yule et al. "Non-technical skills for surgeons in the operating room: A review of the literature". In: *Surgery* 139.2 (2006), pp. 140–149.

[227] F.R.H. Zijlstra, M.J. Waller, and S.I. Phillips. "Setting the tone: Early interaction patterns in swift-starting teams as a predictor of effectiveness". In: *European Journal of Work and Organizational Psychology* 21.5 (2012), pp. 749–777.

[228] C.E. Zsambok and G. Klein. *Naturalistic Decision Making.* NY: Routledge, 2009.