

CHAPTER 1

INTRODUCTION TO THE STUDY

1.1 Introduction

The research problem

South African mines have a poor health and safety (H&S) record. The incidence of fatalities and injuries following falls of ground, during transportation, with explosives or in general mining accidents has been reduced in recent years, but is still unacceptably high. While mine fatalities are highly publicized, disabling injuries are not. Occupational diseases, especially lung diseases and noise-induced hearing loss, are pervasive. Lung disease kills many more mineworkers than do accidents. The exact extent of mortality from lung diseases such as tuberculosis (TB) and silicosis is unknown, because unrecorded numbers of migrant mineworkers simply go home to die. South Africa has a substantial body of legislation dedicated to ensuring the H&S of people at work, and the mining industry has its own dedicated legislation. In spite of extensive legislation and policy development, however, the H&S record remains poor.

The broad and complex subject of mine H&S is based upon an underlying premise, that of ‘ensuring a safe and healthy working environment in mines’ (Guild, Ehrlich, Johnston & Ross, 2001:3). The achievement of H&S is encouraged through compliance with legislation and guidelines, the use of personal protective equipment (PPE), and the provision of training and awareness programmes for employees, the focus of this study. Of particular concern are the categories of workers in the local mining sector who are most vulnerable to accidents and disease and who generally have the least formal education or training, those termed elementary workers (unskilled) and machinery operators and drivers (semi-skilled).¹ They constitute by far

¹ Machinery operators and drivers include drillers; excavation operators; earthmoving plant operators; crane, hoist and lift operators (MQA, 2011:102). Where the term *machinery operators* is used, it includes all of these operators.

the biggest categories of workers in the industry, which I have calculated from official statistics, as being between 70 and 80% of total employees. The researched trend in terms of skills demand is that these categories of workers ‘experience a high replacement demand due to mortality related to occupational and other diseases, and accidents on duty’ (MQA, 2011:102). This study focuses on their training and preparation for dealing with the hazards of the mining workplace. Anecdotal evidence suggests that, even when H&S training happens, it does not assure compliance with documented procedures, nor does it enhance spontaneous and responsive individual or collective efficacy of workers in relation to H&S. This study aims to contribute by investigating an alternative training approach.

1.2 The research

Aim and purpose

The main aim of this study is to inform conceptual approaches to health and safety training for elementary mineworkers in the South African context.² This is achieved by the formulation of a foundational, conceptual framework for mine H&S training that goes beyond informing workers of safe practices, but is underpinned by a rationale of developing worker self-efficacy for H&S, within the challenging context of South African mining and the wider social contexts of under-education, injury and illness. During the course of the study, the role of advocated frameworks, models or solutions comes under critical scrutiny. Three main processes are involved:

- The accepted and documented concept of self-efficacy is analysed with reference to its application to H&S training for South African mineworkers.
- A process of review and discovery identifies additional key formulations (ideas, concepts) for developing worker H&S self-efficacy in the context, by drawing on studies in related disciplines, such as adult education and training (AET), mine health and safety, health education and communication.
- A basic framework of key concepts, based upon issues of convergence and recurring themes across the literature, is collated. This includes logical consideration of those aspects of self-efficacy that can be developed by education, training and awareness programmes provided to mineworkers.

² For the sake of brevity, the term ‘elementary mineworkers’ includes reference to workers categorised as elementary workers, machinery operators and drivers in the mining sector.

Research questions

The research is framed around the following questions:

Question 1: How can the concept of self-efficacy be applied to workplace H&S programmes for unskilled and semi-skilled workers in South Africa?

Question 2: What key formulations (concepts, ideas) from related disciplines have ‘logical relevance’ to the research issue, i.e. worker efficacy for H&S in South Africa?

Question 3: Which formulations (concepts, ideas) are key contributions to a basic, foundational framework for worker efficacy in H&S?

Question 4: Does the tentative framework have meaning in the real workplace context?

Parameters

This is a conceptual study of possible approaches to H&S training and awareness programmes.³ Within the mining sector, the term *awareness* usually refers to training programmes which promote awareness or advocacy but are not formally accredited, while *training* refers to formally accredited programmes. This study includes both types of programme as foci for conceptual development and uses the term training to refer to both, simply to avoid clumsy expression.

³ It may be useful to clarify distinctions regarding the use of terms:

An **approach** is the general, overall way in which we set about our educational activities. It is influenced by what we believe about learning, about human beings, and about the purposes of education and training. Different methods may be used within one approach.

A **method** is a practical way in which we implement our teaching. A method should be an effective way of achieving the educational purpose and should fit in with the general approach. Discussion in small groups is a method. Lecturing is a method.

A **technique** is a very specific method or part of a method. For example, there are various techniques for running discussions in small groups. There are various techniques for presenting a lecture (Aitchison, 2010: Teaching notes).

As stated, the study focuses on the training of those categories of mineworkers who are most vulnerable and least educated, described as elementary workers and machinery operators. While it has much in common with conventional adult education and training studies, it departs from them in two main ways. It crosses the boundaries of different disciplines, and it introduces additional theory at the core of the research: the self-efficacy concept. The study was undertaken within the academic framework of a Ph.D registered in the department of Management and Policy Studies. Consequently, references are made to policy processes and policy logic where these have an impact on training approaches.

1.3 Framing the study

Elements of the topic

The organization of mining operations also contributes to a lack of integration and conceptualization of the topic of H&S training. Production is controlled by production management, usually the mainstream management of a mine, while safety is managed by safety departments, training is provided by training sections, health education is given by health services, and adult basic education and training (ABET) is usually outsourced to private vendors. Practitioners of each department may not see any purpose in consulting the reports of other departments, let alone the literature of another discipline. In the absence of traditional parameters, the researcher is required to deconstruct the topic into its basic elements in order to identify the ‘population’ of literature streams and the terms being targeted for review (Torraco, 2005:361-362; Yorks, 2008:140). The elements of this research topic are the framing concepts that guide the study and the chapter organization. These are deceptively obvious and are clarified below:

- Mine health and safety context: Chapter 2
- Self-efficacy: Chapter 3
- Adult education and training (AET): Chapter 4
- Education and training in mining: Chapter 5
- Health promotion, communication and education: Chapter 6

The reconstruction of these elements towards a common goal constitutes the intended research outcome, aimed at informing and enlightening H&S training for mineworkers.

Self-efficacy

The self-efficacy concept is central to this study because the ultimate aim is to enhance the self-efficacy of workers in relation to H&S. The great number of references available suggests that self-efficacy has developed considerably since the 1970s and is now supported by a substantial body of literature. The most prominent writer on the subject is Albert Bandura, who has published consistently for over 40 years. When the concept is used in Bandura's body of work on behaviour change, it is referred to as a theory of social cognitive learning, but when applied to other disciplines it is referred to as both a construct and a concept.⁴ While self-efficacy emerged from studies of motivation and learning in psychology, the concept has been integrated and applied in many other disciplines. It has generated research in areas as diverse as medicine, athletics, media studies, business, social and political change, psychology, psychiatry and education (Pajares, 2002:10). The self-efficacy concept (or just the term) has been used in the South African education, training and development context with varying degrees of rigour and presumption about what it actually means. It has been used in programmes aimed at developing Defence Force officers (Stadler & Kotze, 2006), supporting previously disadvantaged university students (Wood & Olivier, 2004), teacher development (Wood & Olivier, 2008; Rudman & Webb, 2009), and measuring the entrepreneurial tendencies of different ethnic groups (Urban, 2006).

The Soul City Institute in Johannesburg is a health communication project which uses mass media, including a prime time television drama, *Soul City*, one of the most watched programmes in the country (Goldstein, Japhet, Usdin & Scheepers, 2004). The Soul City project practitioners acknowledge that self-efficacy is one of the significant theoretical influences on their work (Goldstein et al.; 2004:116).

⁴ Self-efficacy is referred to as a concept and a construct in different sources. Bandura's body of work is also referred to as both social cognitive theory and self-efficacy theory in different sources. Rather than engaging in a debate regarding the nature of a construct, a concept versus a theory, this study refers to self-efficacy as a concept.

The concept has also been referred to in previous studies of the health and safety behaviour of mineworkers (Goldstein, 2007; Campbell, 2003; Campbell, 1997; Campbell & Williams, 1999; HEARD, 2002). It has also been used in research into the relationship between individual and organizational efficacy in the coal mining industry (Cilliers & Kossuth, 2007a & b). This study pays more attention to the concept and its use as a conceptual tool for training and development. However, the references cited above indicate that the self-efficacy concept has been acknowledged in related educational, training and development contexts in South Africa, and support this attempt to advance and apply the concept. The concept is extensively reviewed in Chapter 3.

Adult education and training (AET)

This study is undertaken within a broad adult education and training (AET) framework. The ultimate conceptual contribution which it aims to provide is to enhance H&S education or training for adult mineworkers via the incorporation of relevant aspects of self-efficacy and related concepts. It should therefore make reasonable reference to the accepted practices of AET. My own experience also has an effect. I started working in progressive adult literacy agencies in South Africa in the 1980s and more recently moved into mine health and safety awareness. Inevitably, this study is influenced, in its orientation, values and use of language, by many years of work in adult literacy and adult basic education and training (ABET). Relevant approaches and developments in AET are reviewed in Chapter 4.

Education and training in mining

Legislation in South Africa provides legal, logistical and financial support for education and training in the mining industry. Much operator training is conducted in the mining industry, as well as adult basic and adult secondary or further education. Correlations between the formal education of workers and H&S practice are assumed, but are not explored in local mining. Levels of formal education of workers, a common language of communication, and H&S are often perceived as a single issue, that of the low education of workers, as reflected in the influential Leon Commission of Inquiry into Safety and Health in the Mining Industry (1994:70). Consequently, adult basic education and training (ABET) is offered on large mines. A risk assessment process is generally accepted as the appropriate approach to engaging with H&S

issues, and the use of computer-aided learning (CAL) has received much attention (Heyns, 2011; Creamer, 2011; Webber-Youngman & van Wyk, 2009; van Wyk; 2006; Squelch, 2001). Education and training in the mining sector is a big industry, but lacks a critical mass of quality literature. The available literature is reviewed in Chapter 5.

Health promotion, communication and education

In recent years the volume of clinical research on human subjects in South Africa has increased significantly. The HIV and TB pandemics have contributed to this increase. These epidemics have impacted negatively on the mining industry; and mining companies have become increasingly interested in research initiatives that address these problems (Horn, 2007:119).

Health research in mining may be dominated by biomedical as opposed to behavioural studies. Increasingly, research is conducted to assess the effectiveness of interventions, uptake of and attitudes to health education and communication programmes, including health awareness. Such studies are often focussed on employed mineworkers, but several include the local communities in which mines are located, where mineworkers may live or spend their recreational time (Campbell, 1997 and 2003; Campbell & Williams, 1999; Williams, MacPhail, Taljaard, Gouws, Moema, Mzaidume, & Rasego, 2000). Formulations and useful ideas from relevant studies in health education and communication are reviewed in Chapter 6.

Conceptual framework

This study is a critical review of relevant and related research. Broadly, it is located in the qualitative paradigm and is an open-ended, conceptual study that seeks to articulate ideas from related disciplines and to contextualize these with ongoing reference to the demanding realities of South African mining. Local mine health and safety training is an occupation that is relatively less developed in terms of theories and concepts. One of the main intentions of the study is to address some of these conceptual inadequacies and to contribute to making mine training more intelligent and *theoretically informed*. Because of the multi-disciplinary nature of the topic, the study is not positioned neatly within a familiar conceptual framework.

Conceptual frameworks may be referred to in two separate ways in this research: firstly, in order to structure the research and, secondly, as the outcome of the research. The same duality is expressed in other studies: ‘a variety of frameworks can be used to explicate meanings’, as in delineating and clarifying the topic of this study; or as in the outcome of this study, a conceptual framework ‘will formulate and justify alternative conceptual possibilities for grounding the concept’ (Keet, 2006:42).

Ethical framework

Ethics are usually considered as an aspect of the research process. However, I believe that it is necessary at the start of this study to clarify a critical ethical issue. This research seeks to inform education and training approaches for worker H&S, but in no way seeks to exempt any stakeholders in the mining sector from their responsibility to provide a healthy and safe environment for mineworkers. In South Africa, there is a long history of blaming mineworkers when injuries occur (Phakathi, 2006:13; Frankel, 2010:91; Hermanus, 2007:537). This study acknowledges a reported position of the trade unions who ‘see the essence of controlling many otherwise preventable accidents not through expensive, condescending and ethically questionable attempts to change worker consciousness, but by addressing work conditions’ (Frankel, 2010:43). Another relevant critique is the ‘continued inability of mines to manage the seemingly simple business of protecting their workers according to international standards’ (ibid: 83). This study addresses a small strand in what should be a comprehensive H&S system for mineworkers: to improve the quality of training or preparation offered. It is a focused study, located within a very complex context, and thus cannot be associated with any ‘total solution’ to the multiple issues relating to the health and safety of mineworkers.

1.4 Research process

Integrative literature review

The research approach, borrowed from human resource development (HRD), is referred to as an *integrative literature review* (Torraco, 2005; Yorks, 2008; Daley, Conceição, Mina, Altman, Baldor & Brown, 2010). The integrative literature review is a form of research which reviews, critiques, and synthesizes representative literature on a topic in an integrated way, such that ‘new frameworks and perspectives

on the topic are generated’ (Torraco, 2005:356). The result of a comprehensive synthesis of literature is that ‘new knowledge or perspective is created, despite the fact that the review summarizes previous research’ (ibid: 362).

New theory needs to be justified on the grounds of offering potential answers to new and interesting questions not brought to light by existing theory. This justification rests on the existing literature that is being either critiqued or integrated in a new and provocative way. The same is true of integrative literature reviews; what new insights are provided, new questions asked, or answers to provocative questions suggested, by integrating previously separate literature streams (Yorks, 2008:139-140).

An integrative literature review can be classified according to the maturity of the research topic, offering re-conceptualization of a mature, expanding knowledge base, or a holistic conceptualization and synthesis of an emerging or new topic (Torraco, 2005:357). However, while the elements or literature strands constituting this topic may vary in their maturity as disciplines, their integration is a genuine attempt to find a new perspective.

Appropriateness of a literature study

The appropriateness of a literature review for this study is based on two factors: the complexities of access to mineworkers and the fact that research, because of its diverse origins, is never collated or integrated. Access to mineworkers is complicated by logistical, political and economic issues. Most large mines use an electronic system for clocking workers in and out of shifts at the entry point to the mine, similar to those used in many large industries to monitor the movements of workers.

A worker whose entry or exit is blocked knows that he or she must report to a central point to find out why. It may be a call for training, for participation in research, or for routine medical or administrative matters. This is known in local mining as a ‘parade’ or being ‘paraded’. Mineworkers do not have a choice when they are paraded; they do whatever they are directed to do in order to regain access to or exit from the workplace. The parade system facilitates much health-related research in mining, but has been criticized in terms of research ethics:

A mineworker can thus be prevented from going to work or from clocking out post-shift until he has been seen at the medical station, clinic or hospital for any health related issue. From a researcher's point of view, it is a very useful system because workers can be 'paraded' to their follow-up appointments. ...This expedient 'parade' system reflects and sustains the hierarchical mentality in the mining context and overrides worker responsibility for keeping health care appointments. He is simply sent to where he has to go without being part of the decision-making process (Horn, 2007:123).

While the parade system may be useful in retaining contact with research participants, it places the selection and control of participants entirely at the discretion of employers. Cellular phones do not operate underground. Production issues, such as electricity or equipment failure, may also disrupt access to mines. It is extremely difficult for researchers who are not mine employees to secure access to mineworkers more than a week in advance. Many established mining groups and agencies, such as the Mine Health and Safety Council (MHSC), conduct relevant research. However, in the case of government agencies, research findings can only be accessed in special reports, on websites or particular data bases, and mining companies tend to make use of research within their own mining groups:

There are many individual mines and mining companies that aspire to a leadership role in safety enhancement, or are otherwise pace-setters for the industry. ...Yet, their experiences in reducing accidents and injuries remain largely unknown outside the operations and companies concerned, partially because lack of documentation, partially due to the absence of a tradition of knowledge-sharing (Frankel, 2010:90).

Selecting the literature

The selection of sources is naturally based on the elements of the topic or literature streams, outlined above. Apart from the analysis of self-efficacy, the selection and use of sources are deliberately biased towards the specific mining context of Southern Africa, which is often described as unique in the world. This bias is integral to the research process: to discover what works with mineworkers in this context, and to ground any conceptualization in the real context. However, the diversity presents a

challenge. Relevant sources emanate from different paradigms and traditions, including academic studies in adult education and health communication, state policy documents and legislation on AET and mine H&S, special reports on mine H&S, press reports from mine trainers, and annual reports of state agencies and multi-national mining companies.⁵ Relevant peer-reviewed journal articles are sought wherever possible, but minor journals are also consulted. Countless imprecise power-point presentations which appeared at first to be good potential sources were excluded because the authors had neither produced written papers nor responded to direct inquiries for information. Other sources provided insights and cautions, but were excluded from the study because they advocated solutions to H&S or training of mineworkers with little or no substantial evidence. The search for relevant literature involved examining established data bases, search engines, websites, indices of journals and many different permutations of related key words.^{6 7}

The most recent literature that could be found was used, as well as classic texts on mineworker experiences. The diversity of sources also precluded absolute criteria for inclusion or exclusion across the different streams, though the study includes those that are ‘purposeful’ and ‘representative’, rather than just one of these, as advocated by Yorks (2008:140). The process involves judgment, and the sources reviewed are those which seem to be saying things that are particularly typical, telling, well rationalized or relevant to the local mine H&S context.

⁵ Training sections of the Mine Health and Safety Act (MHSA) and the sectoral Mining Qualifications Authority are discussed in Chapter 5.

⁶ Data bases and search engines include: Academic Search Premier, ERIC, Proquest, Medline, Social Science Index, Google. Websites include those of the Departments of Minerals and Energy (DME), Mining Qualifications Authority (MQA), Mine Health and Safety Council (MHSC), National Institute for Occupational Health (NIOH), South African Institute of Mining and Metallurgy (SAIMM), Chamber of Mines, and the Safety in Mines Research Advisory Committee (SIMRAC). Combinations of key words are related to mining, mineworkers, workers, health, safety, training, self-efficacy, adult education, health education, behaviour change, South Africa, etc.

⁷ I was fortunate that I had some access to the MHSC data base before it was shut down and reconstituted in 2010. Research reports are now available at a cost of R500.00 per report.

Engagement and analysis

The study obviously required critical engagement with literature, a process of data analysis that ‘needs to be critical, not accepting, much like comments by interviewees must be probed and critically assessed’ (Yorks, 2008:140). Critique, the product of critical analysis, identifies strengths and key contributions of the literature, as well as any deficiencies, omissions, inaccuracies, and other problematic aspects of the literature.

It also identifies knowledge that should be created or improved in light of recent developments on the topic. Thus, by highlighting the strengths and identifying the deficiencies in the existing literature, critical analysis is a necessary step toward improving the knowledge base (Torraco, 2005:262).

The process of critical analysis of the literature to be used here depends on the nature of the specific source and the data presented. The process may be both deductive and inductive. However the process of synthesising different literature strands in order to formulate new perspectives is essentially an inductive process. An ideal notion of *inductive* analysis is described as one in which ‘the patterns, themes, and categories of analysis come from the data; they emerge out of the data rather than being imposed on them prior to data collection and analysis’ (Patton, 1980:306). This suggests that data are not subject to researcher bias. Quantitative data in mine H&S, even those relating to the causes of accidents, are compiled and reported in this way. However, the scope of research always involves elements of inclusion and exclusion which may reflect bias. Probing more deeply into the issues, such as the causes of H&S lapses, may require an *iterative* process or *iteration*:

The role of iteration, not as a repetitive mechanical task but as a deeply reflexive process, is key to sparking insight and developing meaning. Reflexive iteration is at the heart of visiting and revisiting the data and connecting them with emerging insights, progressively leading to refined focus and understandings. ...From our experience, however, patterns, themes, and categories do not emerge on their own. They are driven by what the inquirer wants to know and how the inquirer interprets what the data are telling her or him according to subscribed theoretical frameworks, subjective perspectives, ontological and epistemological positions, and intuitive field understandings (Srivastava & Hopwood, 2009:77).

The following three questions offer a simple framework for guiding such analysis, but the simplicity of the framework should not imply naïveté about the controversies and challenges in qualitative analysis (Srivastava & Hopwood, 2009:82):

- What are the data telling me? (Explicitly engaging with theoretical, subjective, ontological, epistemological, and field understandings)
- What is it I want to know? (According to research objectives, questions, and theoretical points of interest)
- What is the dialectical relationship between what the data are telling me and what I want to know? (Refining the focus and linking back to research questions)

(Srivastava & Hopwood, 2009:78).

Research outcome

This study does not aim to produce new theory but rather to establish valid and coherent conceptual insights by integrating existing work, creating a ‘value-added contribution to new knowledge on the topic’ (Torraco, 2005:365). The term ‘conceptual framework’ appears to have wide acceptance and reasonably consistent use across the diverse potential audiences for the outcomes of this study, presented as a coherent and related set of ideas. Other terms used loosely in the literature include ‘model’, ‘map’, ‘matrix’, and ‘schema’, though these terms have different uses in different disciplines. A concept map or matrix can be used as a stage in the process of developing conceptual frameworks, laying a foundation for further theorizing (Hay & Kinchin, 2006:130; Torraco, 2005:358).

The outcome of this research is described as a provisional conceptual framework, a specifically focused approach to H&S training of mineworkers. The definition below is useful and comprehensive because it emphasizes that conceptual frameworks are not slavish models to be replicated but serve to illuminate and broaden the process or topic under consideration, from conceptualization to practice.

Conceptual framework is defined as a network, or ‘plane’ of linked concepts that together provide a comprehensive understanding of a phenomenon. Each concept of a conceptual framework plays an ontological or epistemological role in the framework. Conceptual frameworks are not merely collections of concepts but, rather, constructs in which each concept plays an integral role. They provide not a causal/analytical setting but, rather, an interpretative approach to social reality. Finally, they are not determinist frameworks. ...The data themselves are composed of various texts addressing the social, cultural, political, or environmental phenomenon in question and the multidisciplinary literature on the subject (Jabareen, 2009:57).

1.5 Significance of the study

Relevance of the topic

During 2005, I was commissioned by the National Institute for Occupational Health (NIOH) to review literature on modalities suitable for training mineworkers described as illiterate and semi-literate (Tuchten, 2005). While conducting this task and working on materials for mineworkers concerned with lung health awareness, I became increasingly aware of the weak conceptual and theoretical base of the mine H&S training to which I was exposed. My internet searches of mine H&S programmes on offer revealed that many such programmes are targeted at managers rather than underground workers and are designed to assist employers in understanding and implementing the requirements of the legislation in order to avoid punitive fines. Recently, training vendors have begun to advertise more H&S programmes for mineworkers, following pressure to comply with the legislation.

When I sought detail on these programmes I found that many did not really relate to mining practices, but were instead about physical fitness, fire-fighting, or first aid. The learning materials that I was able to access frequently involved informing workers of health and safety procedures, without at the same time providing them with any underlying rationale for doing so. For example, mineworkers were instructed when and where to wear masks (e.g. while using explosives for blasting), but were not educated about the impact of dust particles on lung health or the differences between diseases caused by dust (e.g. silicosis) and those caused by a bacterium (e.g. tuberculosis); this resulted in many mineworkers perceiving all the different lung diseases as one (referred to by them as phthisis). Most of the learning materials I found were produced in English at a reading level that would suit high school graduates, but not those who had not completed school or did not use English as a first language.

My own discussions with mineworkers, trade union representatives and mine personnel revealed that, even when workers were aware of the dangers to which they were exposed, many continued to take risks. Compliance with H&S procedures is low for many complex reasons, the most evident being the hasty pursuit of production bonuses. Existing H&S programmes do not appear to facilitate worker compliance with documented procedures. The efficacy, both individual and collective, of workers in relation to H&S practices remains undemonstrated, undeveloped or dormant, even after they have participated in the few relevant programmes. A more thoughtful and developmental process of facilitating health and safety efficacy that is internalized, sustained and adaptive appears to be a necessary consideration. That is where this study aims to make a contribution. Research into mine H&S is currently being conducted, especially in relation to technological innovation, environmental impact, biomedical studies and possible training modalities. An official of the Mine Health and Safety Council was not aware of any studies, other than this, being currently conducted on approaches to mine H&S training (Banyini-Mulaudzi, 2011).

1.6 Limitations

Maintaining the focus

Research into H&S practices of workers could involve many types of quantitative variables or qualitative factors, but this study focuses only on education and training as contributions to the H&S efficacy of workers. It thus restricts its inquiry to what would constitute a more informed conceptual training approach to enhancing or developing the H&S self-efficacy of workers. Although the self-efficacy concept originated in psychology, this is not a psychological study as such, but is restricted to examining how the concept has been used in the past and how it could be applied in the future in H&S or mine education and training. The boundaries between interventions offered by adult educators and trainers and those offered by psychotherapists are quite clear. The outcome of this study should inform approaches to training, although other programme inputs, such as practitioner, curriculum and materials development, management, evaluation, assessment and language policies, remain crucial issues for further research.

CHAPTER 2

MINE HEALTH AND SAFETY CONTEXT

2.1 Introduction

Scope and purpose of the chapter

This chapter describes the health and safety context of this study. The main mining hazards and risks are identified and South Africa's mine health and safety record is reviewed. It also refers to the wider, national, social and industrial contexts of illness and injury within which the mining sector is located. Current policy, legislation, working conditions and mine culture that affect H&S are also discussed. The purpose of such a detailed chapter on the context is to support the validity of this study by providing a comprehensive and authentic basis for theorizing and referring to appropriate approaches for training.

2.2 South African mining industry

Significance of the sector

Many of both the positive and negative features of contemporary South Africa originated in the mining industry, including a huge resource base, influential trade unions and a pernicious migrant labour system. South Africa possesses some of the world's largest known mineral reserves.⁸

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Table 1: South Africa's commodity reserves in terms of world resources:		
SA ranked 1 st in the world	Ranked 2 nd in the world	Other ranked reserves
chrome	fluorspar	coal 4th
gold	titanium	phosphate rock 4th
manganese	vanadium	uranium 4th
platinum group metals (PGMs)	vermiculite	diamonds 5th
	zirconium	nickel 5th
		antimony 6th
		lead 6 th

(Source: COM,2010b:7 and SouthAfrica.info, 2009)

Though this vast and complex sector has declined in the last decade due to fluctuating commodity prices and demand, increased costs and the world economic recession, it is still significant both globally and to the South African economy. Many South African companies responded to economic and political change by globalizing, shifting their primary listings from Johannesburg to London and New York and venturing into other countries, especially in Africa (Bezuidenhout, 2008:183). In 2009, mining contributed 8,8% directly to the national Gross Domestic Product (GDP) and 19% indirectly (COM, 2010b:2). Mine finance is extremely complicated. Vast amounts of money are at play, but it is not a matter of simple profit and loss, as commodity prices have a huge impact on balance sheets. The total income of the formal mining sector was R322 billion in 2008 (ibid).⁹

Employment in the sector

The number of people directly employed in mining has stabilized at about 500 000, well below the 850 000 employed in 1985 (MQA, 2010:xiv). However, it remains the formal sector that provides the most employment. Total employment at the end of 2009 was estimated at 548 000, including both permanent employees and contract workers (MQA, 2011:10). In addition to the direct mining jobs, about 500 000 workers are estimated to be employed by the suppliers of goods and services to the industry, and at least 5 million people are believed to be dependent on the wages of mineworkers (SouthAfrica.info, 2009). In 2009, some R71 billion was paid to mineworkers in the form of salaries and wages (COM, 2010b:2). Africans constitute 86% of the total workforce and whites 13%, while only 10% of employees are women (MQA, 2011:16-17). The majority of employees in the sector (62%) work for large organizations, with 5000 or more employees, while another 34% work in smaller organizations, ranging in scale from 150 to 4999 employees (ibid:11).

⁹ The following quote indicates both the scale and complexity of local mining finance:

The total income of the South African mining sector was R332 billion, down by 8.8% on 2008. The industry's total expenditure, excluding dividends, taxes and capital expenditure, was R312 billion, implying a small gross surplus of R20 billion. However, if taxes, dividends and capital expenditure are included, the total expenditure of the mining industry was R399 billion in 2009, implying that a deficit of R67 billion was incurred (COM, 2010b:2).

It is possible to calculate from the sector skills plan that, of the 547 973 people employed in the mining sector in 2009, 400 574 were categorized as *elementary workers* or *machinery operators and drivers*, the focus of this study (ibid:17). Comprising over 73% of the total workforce, these workers are generally the least formally trained, but the most consistently exposed to H&S hazards. The proportion of workers underground is also much higher in gold mines (DME, 2008:14).

2.3 Working conditions and culture

This section aims to describe aspects of current mine culture and working conditions that affect health and safety. In order to discuss trends and tendencies, it is necessary to rely on generalizations and accepted stereotypes. I am reluctant to describe mining personnel at any level in terms of stereotypes, but much of the literature that does so also provides useful ideas and insights.

Migrancy

Each year, for well over a century, hundreds of thousands of men from rural areas of South Africa and neighboring countries have come to seek work in the mining sector. They are not immigrants in the usual sense, as they work for periods in the mines, go home and then return. This is termed oscillating or circular migration (Rees, Murray, Nelson & Sonnenberg, 2009a:398). The migrant worker system on the mines was a product of nineteenth-century colonialism and mercenary attitudes to the exploitation of people and resources. Local mining conditions presented challenges in terms of the depth of mining required and the matrix of hard rock in which precious metals and minerals were found. Early South African mining magnates responded, as many still do today, by seeking cheap labour from the entire sub-region:

It wasn't just the material wealth that Rhodes and company needed from the neighbouring countries. There was a major problem with the gold on the Rand. The geologists quickly found that most of the gold was deep underground, embedded as tiny speckles in huge volumes of hard quartz matrix (only 10 g of gold in 1 tonne of ore). The deeper the gold, the more expensive it was to mine. ... South African mines needed manpower from neighbouring countries (Hargrove, 2008:57).

Subsequent policy and legislation entrenched a system of migrancy and inequality. The Mines and Works Act of 1911 (amended and extended in 1924) formalized job reservation, with the result that skilled jobs could not be offered to African mineworkers. Other statutes, such as the 1913 Native Land Act, the 1920 Native Affairs Act and the 1923 Urban Areas Act, limited the land ownership, entrepreneurial opportunities and movement of people, entrenching racial discrimination, white supremacy and migrant labour within the industry. Black workers lived in single-sex hostels, while their families were forced to remain in 'homelands' or neighbouring countries (Oakes, 1988:264-265; Horn, 2007:123). Over 100 000 foreign workers continue to be employed by South African gold, platinum and coal mines each year (Rees et al., 2009a:399). Approximately half the gross national product of Mozambique and Lesotho comprises mineworkers' remittances; foreign countries thus have an interest in preserving the current system. Migration of workers from rural areas within South Africa and from neighbouring countries remains an ongoing feature of mine employment. A migrant lifestyle has been associated with social disruption and a range of negative consequences, including the denial of normal family life, break-up of marriages, and poor living conditions in single-sex hostels (DME, 1998). 'Although much has been published on the linkages between migrancy and health, the mining industry itself seems to lack awareness of the seriousness and long-term implications of the matter' (Rees et al., 2009a:403). The system aggravates indifference to health and safety on many levels, as revealed in research into the health awareness of workers in relation to dust and silicosis:

In focus group discussions, health and safety representatives stressed that migrant workers 'are here only for the money and no other reason', which exacerbates the tension between the pursuit of bonuses and working safely. ...Health specialists speculated that workers who grow up in traditional mining communities, such as the coal fields of Britain, are more likely to be exposed to cautions about lung disease in their indigenous knowledge systems than migrant workers (MHSC, 2009b:41).

Hierarchies and control

Obviously much has changed since the dismantling of apartheid in 1994 but a hierarchical system of racial subordination, built over a period of more than 100 years, unfortunately still casts a shadow over the industry. The mining industry, like the military, is an hierarchical organization, with all jobs classified into groups or grades according to skill and responsibility. Status and privileges such as accommodation and bonuses are usually awarded according to these categories (Horn, 2007:122).

The electronic ‘parade’ system referred to in Chapter one and the rigid hierarchy in mining maintain a form of control over mineworkers that can be inflexible and anonymous, reinforcing long-held feelings of powerlessness in relation to the workplace. Attitudes associated with a lack of power or control have frequently been described as contributing to lapses in mine H&S (Campbell, 1997 and 2004; Campbell & Williams, 1999; Williams, MacPhail, Taljaard, Gouws, Moema, Mzaidume & Rasego, 2000; Frankel, 2010). ‘Among men employed on the mines, levels of self-efficacy associated with health-promoting behaviour appeared to be low: high levels of disease and injury were regarded as the norm, and miners felt that there was little that they could do to protect their health in their unhealthy and dangerous working and living conditions’ (Williams et al., 2000:352). Furthermore, weakened efficacy in terms of H&S appears aggravated by the pursuit of production bonuses and by masculine bravado.

Production bonuses

Mines all over the world are production driven. There are many accounts in Dunbar Moodie (1994) of how workers were physically abused by the strongest and highest-paid member of the team to reach production targets. This has changed over the years:

The physical violence needed to generate regular outputs of rock is very much a thing of the past - but by no means at the smaller mines outside the public spotlight. This has been replaced with economic inducements as well as more subtle and possibly even more painful psychological instruments of control whose purpose is to reinforce the compulsion to work (Frankel, 2010:25).

A mineworker who works extra-long hours at a fast pace to reach optimum production targets can treble or even quadruple his basic wage, though the calculation of bonuses varies from mine to mine. A formal survey in the mining sector found that a significant proportion of employees believe it is *necessary* to cut corners to achieve production goals, indicating a high level of risk-taking (Hill & Pitzer, 2005:27). Production goals are formulated by management, who hardly ever venture underground, and are then communicated to supervisors and ‘team leaders’ to be achieved. It is widely reported that team leaders prioritize production over safety (Frankel, 2010:25-26; Campbell, 2003:28-29; Hill & Pitzer, 2005:27). ‘We know from interviews and observation that supervisors, teams leaders and members can be extremely vicious to co-workers who fail to perform in the most efficacious (if dangerous) way, or who otherwise inhibit the group urge to reach or go beyond production targets (Frankel, 2010:25). Examples of reported censure are:

- It is not infrequent for new or questioning members of teams, particularly those who do not conform to the stereotype of the burly miner, to be assigned the most dangerous work as part of underground initiation. This is sometimes with the connivance, or under the authority, of the supervisor (ibid).
- There are many cases where fearful operators who have refused to accelerate production with the conventionalized short-cuts, have been called up and ‘dealt with’ once teams have reached the safety of the sunshine. This includes physical assault by co-workers in the compounds or other habitats where operators spend their off-shift hours (ibid).

It is not possible to gauge the pervasiveness of such behaviour, but production-driven supervisors are clearly a weak link in mine H&S. A clear chain of command may be necessary underground. Yet the recurrence of such anecdotal evidence indicates that specific training for team leaders on how to balance H&S and production pressures is a priority. H&S lapses are spoken about quite freely in the industry, and a few examples relating to lung health follow. *Re-entry times*: I have been told that ‘nobody’ working underground waits for the mandatory three hours for dust to settle after blasting, before re-entering the work area. Thus large amounts of noxious dust particles are inhaled.

Watering-down: mineworkers are advised to water down the work area repeatedly during a shift to settle the dust, but are reluctant to interrupt production tasks to do so.

Ventilation: two members of each panel or team of mineworkers (about five people) are responsible for extending ventilation along mined tunnels to the development end, where ore is currently being excavated. Each mine has a standard regarding how far this ventilation should be extended, usually 12-15 metres from the farthest end currently being mined. In order not to waste time, ventilation pipes/columns are often not extended and thus end up to 60-100 metres from where the team is working, leaving them to breathe the limited air available. These are all time-consuming procedures. Yet simply changing the bonus system is not necessarily the solution. The bonus system is used in mining in many parts of the world, even those with optimal H&S rates. Unionized workers elect to work with the system because of the potential for much higher income: ‘Our miners towards the bottom of the socio-economic hierarchy are far less attracted to safety bonuses than their international counterparts who have relatively greater skills and opportunities to transfer out of the industry along their career trajectory’ (Frankel, 2010:26).

Masculinity or machismo

Most mineworkers are young men who risk their lives daily by going deep underground to look for metals. Many work 12-hour shifts per day with only short breaks for 10 days in a row. Exposed to hazardous working conditions and the risk of physical injury, mineworkers tend to preoccupy themselves with other immediate challenges and may regard HIV as a distant threat. In such conditions, there exists a strong form of masculine identity which encourages high levels of sexual activity and alcohol and drug use as a way of dealing with the stressful lifestyle. Such risk-taking mentality is further aggravated by mineworkers’ sense of lack of control over their life circumstances, absence of social constraints that prevail at home, and poor living conditions (IOM, 2010:10).

Much has been written about the interplay of mineworker conceptions of masculinity and risk-taking in relation to HIV (Campbell, 1997 and 2003; Campbell & Williams, 1999; Williams et al.; 2000). However, assertive masculinity and risk-taking are probably relevant to many H&S issues.

‘Masculine identities serve as an important coping mechanism whereby miners deal with the stresses and dangers of their working lives’ (Campbell & Williams, 1999:22; Campbell, 2003:32). Interviews on a local gold mine revealed typical attitudes: ‘A man was someone who had the responsibility of supporting his family and hence had no choice but to put up with the risks and stresses of working underground. ‘A man was someone who was brave enough to withstand the rigours of the job,’ (Campbell, 1997:278 and 2003:32). The masculine identities and actions of local mineworkers may also have specific cultural influences: ‘In the highly patriarchal rural communities from which many mine workers originate, one of the main pillars of masculine identity construction is participation in homestead and family leadership. ‘In the particular context of life on the mines, many migrants are deprived of such key markers of masculinity,’ (Campbell, 1997:279; 2003:34). Yet certain forms of risk-taking and of aggressive and macho masculinity are common amongst communities of working men in a range of contexts and occupations, such as shipping, policing and the military. It may be a matter of degree, but it is not peculiar to South Africa or to mineworkers. ‘Safety is frequently seen as a ‘soft’ value, not only in local mining but in other industries such as deep sea oil drilling and the production of petro-chemicals’ (Frankel, 2010:24).

Black Economic Empowerment (BEE)

The mining industry is seen as one of the key drivers of Black Economic Empowerment (BEE), as it was one of the first sectors in which substantial black empowerment deals were struck (Bezuidenhout, 2008:183). It is also described as the largest contributor by value to BEE in the economy, in terms of the value of BEE transactions completed (COM, 2010b:2). The transformative potential of BEE has been challenged in terms of its positive effect on underground mineworkers. Analysis has identified tensions between contesting notions of BEE: ‘One notion primarily focuses on black ownership. ...The other argues for a more holistic approach viewing issues such as decent employment standards, skills development and employment equity as ways to overcome apartheid,’(Bezuidenhout, 2008:186). Further legislation relating to employment equity requires that by 2014 a minimum of 40% of a company’s employees at executive, senior management, core and critical skills, middle management and junior management levels should be historically disadvantaged South Africans (MQA, 2009: xvii).

However, such wider empowerment legislation does not equate with change for the average mineworker, since there are relatively few managers at all levels across the industry. In 2009, managers comprised only 2% and professionals 4% of total employment, while technicians and trade workers formed 14% of the workforce (MQA, 2009:41). An even lower proportion of managers ever go underground. ‘With a few singular exceptions, few team leaders, front-line supervisors, shift bosses and other supervisory personnel figure in the death statistics’ (Frankel, 2010:9).

Contracts

The use of contract labour in the mining sector has increased dramatically since the 1990s. For the majority of South African mineworkers, a standard contract of employment was something that was fought for over decades (Bezuidenhout, 2008:187). Yet one out of every three mineworkers is now employed by a contractor other than the company that owns the mine (ibid:189). Casualization usually involves a shift from full-time employment to part-time, fixed-term casual or piece work, often effected through a labour broker. Contract working conditions are no longer subject to regulation by the state or other agencies, and workers do not have benefits, such as training and medical monitoring. The lack of training applies to H&S training as well as to regular upgrading of skills in terms of newer and safer technology. Contract workers are often offered more dangerous work for lower wages and are not permitted to join trade unions (ibid:194-196). The reasons for the rise in contract employment in the last decade could not be addressed in this review.

Multinationals

A related concern regarding mine culture is the H&S of multinational corporations. Some multinationals report that their South African operations have the worst H&S safety rates, bringing down the group’s international profile, and thus providing incentive for initiatives (Frankel, 2010:12-17). However, research into the experiences of mineworkers revealed that certain companies may be more mindful of H&S issues when operating in South Africa than when operating in other African countries, particularly Zambia, Zimbabwe and Tanzania (Jauch, 2007:13-14; Eweje, 2006:175).

Multinational mining companies have been accused of double standards in not complying with mining regulations in developing countries, as they would have done in developed countries. Even though the managers of MNEs interviewed in South Africa denied this allegation, other stakeholders such as the unions, the press and producing communities argue that this is indeed the case. They alleged that MNEs take advantage of discrepancies in host countries in order to pursue a profit (Eweje, 2006:175).

2.4 Health and safety context

National context

South Africa as a country has high recorded levels of accidental injury, interpersonal violence and ill-health due to HIV Aids. This means that the national context presents a dysfunctional base from which to develop mine health and safety efficacy. The same can be said of local industry generally, which also has a relatively poor H&S record. The population is generally described as unhealthy, mainly due to HIV Aids. South Africa has the largest number of people living with HIV in the world. UNAIDS/WHO estimate that at the end of 2007 there were 5.7 million people living with HIV in the country, including 3.2 million women and 280,000 children aged 0-14. There is significant variation in HIV prevalence by province, ranging from 39.1% in KwaZulu-Natal to 15.1% in the Western Cape. Inter-district HIV prevalence variation in the country is between 46% and 5.3% (UNAIDS, 2010:n.p.). Oscillating migration influences HIV spread by creating a social and economic system that encourages multiple partners and concurrent partnerships. Thus, industries that rely on migrant labour (mining, heavy engineering, metal processing, and transport) appear to have the highest burdens of HIV, above the national average of 18.8% in the adult population aged 15–49 years (Rees et al., 2009a:401). The migrant lifestyle of many mineworkers, living in single-sex hostels, separated from their wives and families for long periods, has been associated with increased HIV rates (ibid). It is estimated that 27% of workers in gold mining and 24,6 % of workers in platinum mining are HIV positive (ibid:5). Over the last decade, the prevalence of HIV in the mining industry has exacerbated the pattern of occupational diseases, especially those which are infective, such as TB. Nationally, South Africa is also regarded as relatively unsafe.

The injury profile of South Africa, i.e. rates and causes of fatal and disabling injuries, has been compared to those of developing countries in Africa, Latin America and Asia (Norman, Matzopoulos, Groenewald & Bradshaw, 2007). The findings revealed high intentional and unintentional injury rates in South Africa. Apart from road traffic accidents, unintentional injury rates in South Africa were comparable with those resulting from fire and floods. In contrast to other regions, South African homicide rates were greater than road traffic and suicide rates, though none of these could be considered low (Norman et al.; 2007: 697). Relevant findings were:

- South Africa has by far the highest rates of interpersonal violence. The age-standardized homicide rate (64.8 per 100 000) places South Africa among the most violent countries in the world, with homicide rates slightly higher than those reported in Colombia (60 per 100 000). Age-standardized mortality rates related to interpersonal violence are seven times the global rate (ibid: 695-697).
- The South African road traffic fatality rate is higher than for any WHO region, almost double the global average, and road traffic injuries are higher than in the African and South-East Asia regions. This high burden is caused by unsafe road environments, poor enforcement of existing traffic laws, road rage, aggressive driving and misuse of alcohol (ibid: 698).
- High levels of gender-based violence are evident in female homicide rates. South Africa has the highest reported intimate female homicide rate in the world (ibid: 697).

Risks are even higher for mineworkers, because they fall within the population group most vulnerable to homicide and accident, i.e. young males. Homicide rates for young South African males are nine times the global rates, while assessments of the comparative burden of disease have revealed the substantial role of injuries in premature mortality and disability among young adults in Africa, particularly males (ibid: 695-696).

Industrial context

South African industry generally does not have a good health and safety record. Several national commissions of inquiry have attempted to investigate occupational H&S in South Africa, the most influential being the Benjamin and Greef Committee (1997). Two findings of the Benjamin and Greef Committee recur in subsequent research:

- Occupational accidents and work-related ill-health impose a considerable cost on the South African economy and society (ibid:3);
- There is inadequate reporting of occupational accidents and, to a greater extent, of work-related ill-health. This prevents the determination of the full extent of these problems and the development of preventive strategies, and deprives employees of compensation benefits (ibid:4).

A more recent study describes South Africa as a country in which it is estimated that 9% of men and 5% of women annually report suffering from a work-related injury or disease, with an accident rate of 33,4 per 1000 workers (Naidoo, Jeebhay, Robins, Myers, Nogueira & Zeleznik, 2006:392). Australian occupational H&S statistics available for 2007/8 cite a rate of 13,8 serious incidents, including both injuries and illness, per 1000 employees (Safe Work, 2011:3). With reference to the wider southern African region: ‘Occupational injuries and fatalities, and especially occupational diseases, are believed to be grossly underestimated in the currently reported data. Actual occupational disease rates are estimated to be 50 times higher than the reported rates’ (Naidoo et al.; 2006:393). Possible explanations for this are the high proportion of people, over 60%, who work in the informal sector and agriculture. The growth of the informal mining sector is discussed later in this chapter. Only 11 to 18% of workplaces in South Africa provide any form of occupational health service, while the figure is even lower in other countries in the Southern African region (ibid:393).

Effect of the contexts

The country’s context of violence, injury and illness creates layers of hazard in which citizens become inured to danger and risk, even defeated by it, perceiving these as part of the inevitable burden of work and life.

Health workers describe a sense of fatalism, as opposed to self-efficacy. There is also a general culture of impunity in the country, evident in small ways in incidents such as traffic violations and, at higher echelons, in corruption. These attitudes and behaviours in society have a negative spill-over effect in the workplace, including the mining workplace, engendering risk-taking and countering compliance with H&S guidelines:

Many of the values about life, occupational behaviour and risk-taking derive from these external sources and are then transmitted, no matter the barriers, into the workplace. This includes world-views conditioned by life in high-risk communities from which workers trek into the mines, as well as more tangible factors salient to safe work behaviour (Frankel, 2010:31).

The Leon Commission of Inquiry into Safety and Health in the Mining Industry (1994) made a comparable observation, referring to ‘this sad South African syndrome that life is a little cheaper in South Africa than elsewhere’ (Leon et al.; 1994:74). The response of the Leon commission was pithy: ‘It is important to remain optimistic’ (ibid:74). A more productive policy may be to learn from other disciplines engaging with personal and community values and behaviour towards health, safety and injury. Widespread injury and disease provide dysfunctional starting points for developing worker efficacy for H&S and require acknowledgement in training programmes. This issue is discussed further in Chapter 6 in relation to health promotion and communication.

2.5 Overview of mine health and safety

Introduction

Mine health and safety has been intensively researched, in comparison to other industrial sectors in South Africa. The Leon Commission (1994) informed much current legislation and policy. Information and data were updated in the more recent Presidential Mine Health and Safety Audit (DME, 2008). Comparisons across different industries are problematic, due to the differing nature of the work involved, but mining has been described as the second most dangerous industry in South Africa.

The severity rate (SR) in industry is a widely used calculation, indicating the number of days lost due to accidents for every 1000 hours worked. The mining industry SR is the second highest, after fishing, and is followed by transport and construction, indicating that these are the four most hazardous industries in South Africa (Smallwood & Haupt, 2005:3). Based on serious claims per employee: Australian mining is regarded as the seventh most dangerous sector in that country, after transport, agriculture and fishing; transport and storage; manufacturing; construction; personal and other services; and wholesale trade, but remains more unsafe than the average industrial sector in Australia (Safe work, 2011:7).

South African mining conditions

South African mining operations vary from small open quarries, where workers use hand tools, to highly sophisticated and mechanized systems operating at depths of four kilometers underground. All of these operations are considered mines and are theoretically subject to the same legislation. Particular mining methods and working conditions are informed by the depth of the ore, the geometry of the ore body, the physical properties of the rock being mined, and the available resources or technologies. These factors determine whether labour-intensive, capital-intensive, underground or surface methods are used. Most minerals in South Africa, except for coal, require labour-intensive, deep underground mining. South African mines are relatively labour-intensive, when compared to similar operations in countries like Australia and Canada. This is because most of the precious metals mined here, especially gold, occur in the form of tiny particles in huge volumes of hard quartz matrix, requiring labour-intensive mining methods (Hargrove, 2008:57). Labour-intensive, as opposed to capital-intensive mining provides much needed employment but exposes comparatively more workers to underground hazards. In South African gold mines, about 84% of employees work underground, whereas across the mining industry as a whole about 60% of employees are underground workers (DME, 2008:14). South African mines are deeper than those in other parts of the world. Local gold mines are by far the deepest in the world, with many working places as deep as 4 km. Half of the entire mining workforce is by definition employed in deep mines, i.e., at depths greater than 1,5 km, which means that relatively high numbers of workers are exposed to high-risk conditions (ibid: 15).

Associated with these depths, are fall of ground, rock bursts and seismic activities due to pressure built up in the rock mass. ...As mines go deeper, the problem of seismicity and seismicity-induced fall of ground will no doubt increase. Currently, there is no way that the enforcement authority can get access to seismic information for proactive prevention work. This information is often only made available by mines after injuries and deaths and cannot be relied on because it always indicates that there were no major warnings before the main incidents that injure and claims lives (ibid: 15).

Additional to concerns about seismic activity is the fact that deep mines are also less healthy because the management of ventilation, temperature control and overall technical maintenance are more difficult. H&S is also compromised by the large number of workers on a single mine, which presents significant organizational and logistical challenges (Hermanus, 2007:532). A greater number of South African workers are exposed to health and safety risks than their counterparts in other parts of the mining world (DME, 2008:12). Local mining conditions are sometimes used to challenge comparisons with the mine health and safety achievements of other developed countries, but the technically demanding conditions of South African mining logically require a sophisticated and comprehensive H&S system.

Health and safety divide

Occupational health and safety are usually dealt with as two separate domains in mine reports, with relevant information being accessed in different places and formats. Although occupational health is a much greater problem for mineworkers, accidents attract more attention, both within the sector from workers, managers and trade union officials and from outside the sector from the state, the media and the public. Mineworkers (and H&S representatives) report that their biggest fear underground is of rock falls (Campbell, 1997 and 2003:29; MHSC, 2009b:31). These accidents are usually fatal, and are naturally more tangible issues to engage with than insidious illness. The MHSC state that inspectors in the field still consider safety issues to be of paramount importance, with occupational health coming a distant second: 'An influencing factor is that many mining inspectors feel that occupational health is the realm of other specialist occupational hygiene or medical inspectors' (MHSC and Resolve, 2003:10). The slower onset of disease is also relevant:

Manifestation of disease is not uniform in all individuals exposed to the same working conditions. Disease may be the result of a number of causes, some of which are specific to the workplace and others unrelated to occupation. More often occupational and lifestyle effects co-exist in the causation of disease, for example smoking and silicosis. The relationship between exposure and manifestations of the detectable health effects is complicated by the long period before the health effect can manifest itself (DME, 2008: 27).

While the neglect of occupational health is widely acknowledged, it remains a serious gap in local H&S policy, practice and training.

2.6 Mine safety

Safety hazards

The literature on mine H&S makes clear distinctions between hazards and risks. Hazard is the potential to cause harm. Risk, on the other hand, is the likelihood of that harm occurring (NIOH website, 2009). The main *safety* hazards in the local mines are comparable across the four biggest sectors, those of gold, platinum, coal, and diamonds. Mining gold and platinum in particular involves very similar conditions.

Gold and Platinum	Coal	Diamonds
Rock falls/ rock bursts as a result of mining depths Machines coming into contact with persons in confined spaces Falling materials & rolling rocks Inundations by mud or broken rocks Falling into excavations / from structures Exposure to dust, gases, fumes Explosions and fires Seismicity High temperatures (up to 58°C if uncontrolled)	Rock falls Coal dust explosions Methane explosions Machines coming into contact with persons Fires from spontaneous combustion Falling into or from excavations	Mud rushes Air blasts Machines coming into contact with persons Rock falls Rolling rocks (from draw points) Falling into or from structures Vehicle accidents

(Source: DME, 2008:16-18)

Over the long term, the biggest contributor to fatal mine accidents is the fall of rock or ground due to the depth of South African mines, with transportation accidents being the second biggest risk (MHSC, 2009a:2). Mine accidents invariably involve the lower-grade operators who make up the bulk of mine labour - drillers, winch and scraper personnel appearing to be most at risk. Fatal accidents occur most frequently amongst mineworkers aged 40-49, many of whom have been underground for many years (Frankel, 2010:8-9). It is not possible to suggest a connection to training or experience on these indicators. Different factors contribute to fatal accidents at different times, but an overall trend is presented below:

Table 3: Causes of fatal mine accidents 2004-2008	Number of fatalities
Fall of ground	400
Transportation	250
General (includes falling from heights, mud slides and drowning)	221
Machinery	63
Explosives	25
Electricity	24
Conveyance Accidents	18
Miscellaneous	16
Fire	13
General Heat Sickness	4
Diving Sickness	3

(Source: Frankel, 2010:6)

Causes of mine accidents

Apart from the fall of rock or ground, mine accidents generally involve elements of human control or error which confirm a role for self-efficacy. Human factors are further indicated in the timing of accidents. For example, analysis of the time frames for accidents in the Anglo Platinum mines revealed that the highest rates of accidents seemed to occur immediately prior to or during the period of high public holidays in April and May (Easter, Freedom Day and Workers' Day) and just prior to the Christmas holiday period, for which the following explanation is offered:

There are two likely influences on this trend, that workers are distracted by the prospect of a break and therefore lose their safety focus, and that the production tempo is raised by management to offset the loss in production during the two holiday periods (van Wyk, 2008:57-58). Although this pattern presents the situation at Anglo Platinum, industry safety experts agree that it reflects an industry-wide pattern (ibid:57). Accidents are also reported to occur at the beginning and end of work shifts:

Many mining accidents also occur either soon after the beginning of a shift or towards its end. In the latter case this is often related to the fact that the preceding shift has not tidied the physical mess that occurs with mining, or because the new shift has not been warned of unmitigated hazards that have been encountered. The new team may then casually proceed with its daily blast that literally ‘brings the house down’. Accidents occur towards the end of shifts, some of which extend over the normal eight hours. In these cases fatigue wears down hazard-recognition capability, or induces people to circumvent an imminent danger in their haste to return to the surface. Night-shift accidents can occur for the same reasons or because front-line supervision is too thin to allow risk consultation between operators and their immediate superiors (Frankel, 2010:38).

Mine safety rates

Over the long term, South African mine safety is improving, probably due to improved mining methods. Mine safety statistics for the 1980s reported annual fatalities of 700-800 mine workers each year. More recent statistics suggest that about 200 mine workers are killed in accidents in the formal mining sector each year as revealed in the next table:

Year	Fatalities	Rate per 1000 workers	Fatality rate per million hours worked
1999	309	0,76	0,34
2000	285	0,72	0,33
2001	288	0,75	0,34
2002	290	0,75	0,34
2003	270	0,65	0,29
2004	246	0,56	0,25
2005	201	0,45	0,20
2006	199	0,44	0,20
2007	220	0,45	0,21
2008	171		0,15
2009	167		0,16

(Sources: DME, 2010:72; COM, 2010b:1; DME, 2008:20)

Reportable injuries were 3 750 for 2008 and 3 672 for 2009 (DME, 2010:73), though this probably understates the true position because of under-reporting of non-fatal accidents. Some of these injuries were amputations of limbs that translate into loss of an ability to earn an income, loss of quality of life and increased medical bills (DME, 2008:5). The total number of fatal and disabling accidents appears to decrease over time, but these statistics can be misleading, as the total number of workers employed in the mining sector varies substantially with the rise and fall of commodity prices, especially gold and platinum. In order to establish trends, analysts usually use the industry fatality rate per million hours worked:

Sector	South Africa	International Benchmarks
Gold	0.25	0,09
Platinum	0.10	0,04
Coal	0.17	0,04
Other sectors	0.13	0,04

(Source: Frankel, 2010:15)

Comparative safety rates

Because of the depth of the workings and the differences in the mining conditions, comparative analyses of mine safety are often dismissed by local mining practitioners. Such comparisons are also unhelpful when used by mineworkers or managers to berate each other during labour disputes. Within the work context, many levels of employees are subject to production pressures from higher levels of management, while operating within the wider national environment of poverty and exposure to and tolerance of injury and ill health. Comparative statistics are most constructively used to set international benchmarks and targets. Yet the H&S record of the South African mining sector is poor, when compared to mines in developed countries such as Australia and Canada. ‘Comparison of Australian and South African rates suggest that miners are 4–5 times more likely to lose their lives in mine accidents in South Africa than in Australia’ (Hermanus, 2007:532). In general, South African mining is considered to be considerably less safe than in the United States, Australia and Canada, but much safer than countries such as Russia, India, China, especially Chinese coal mining, and parts of Indonesia, South America and Eastern Europe (Frankel, 2010:11). Accurate statistics are not available.

Outside the ‘First World’ mining injuries are appallingly high. This includes India and China where the extraction of minerals and metals takes place at some of the most dangerous sites on earth. Curiously, Turkey has the highest ratio of mining injuries to deaths apparently because of the high incidence of head injuries in low-slung shafts (Frankel, 2010: xiii).

2.7 Occupational health

Occupational health burden

Mine safety is more widely reported than occupational health, as many countries do not have comprehensive sources of occupational health data. The reliability of such data is especially a problem in developing countries, where reporting systems and reporting criteria are not well established (Hermanus, 2007:533).

Even the recent and comprehensive Presidential Audit (DME, 2008) dealt with occupational health much more generally and briefly than safety, though surveillance of occupational diseases is improving. According to the Presidential Audit, the general incidence of mining occupational diseases appeared to rise between 2006 and 2007, but this has been ascribed to increased compliance, an increase in the reporting of diseases, and early recognition of occupational diseases in an effort to eradicate them by 2013. ‘A total number of 493 annual medical reports have been submitted for the year 2007-2008 as compared to the previous reporting period, where only 226 mines submitted annual reports in terms of section 16 of the Act,’ (DME, 2008:32-33). Policy implementation of the MHSAs has brought about better surveillance, if not actual occupational health achievements. Accurate occupational health data may not be available for South African mines, but there is extensive evidence that the health burden of mineworkers is very bad. A sample is presented here. According to Hermanus (2007), the International Labour Organisation (ILO) estimated that the total number of occupational disease-related deaths in South Africa was 8229 in 2001. Available data suggest that a disproportionate number of these would relate to workers employed in mining and that there is a huge burden of occupational disease among former and current miners (Hermanus, 2007:533). According to research conducted at the National Institute for Occupational Health, about 167 workers were killed in mine accidents in 2009, but at least 669 current or ex-mineworkers died of respiratory illness according to autopsy data (Murray, 2011: Personal Communication). Real numbers are probably much higher because sick workers elect to return to their places of origin. Clearly, many more workers suffer and die from lung disease than in mine accidents. Every year, many more workers are removed from higher-paid underground work as a result of occupational diseases than because of injuries, as shown in the table below, which states the reasons why workers were removed from physically demanding work. Current statistics are not always available:

Table 6: Mine workers: Occupations changed due to occupational disease or accident (all mines)		
Year	Occupational disease	Accident
2005	1530	398
2006	1114	377

(Source: DME, 2009b:n.p.)

Health hazards and risks

The occupational health hazards in South African mines generally are listed as:

- Heat due to rock temperatures at depth
- Exposure to silica dust, the result of breaking up quartz, which is the most common substance in the earth's crust
- Noise, often made worse by confined spaces
- Vibration from machinery
- Ionizing radiation
- Exposure to chemicals in refining processes
- Other airborne pollutants, such as chemical fumes, coal dust

(DME, 2008:27; Hermanus, 2007:534).

These hazards can result in the following occupational diseases which occur across the different sectors of the mining industry in the following order of frequency: (DME, 2008:33):

1. Pulmonary Tuberculosis - usually referred to as tuberculosis (TB) - is a lung disease caused by infection with an inhaled bacterium, *Mycobacterium Tuberculosis*.
2. Noise-Induced Hearing Loss (NIHL).
3. Silicosis - previously known as phthisis - is scarring of the lungs due to inhalation over a long period of dust containing silica crystals. As the scarring increases, the lungs are less able to function properly.
4. Silico-Tuberculosis - refers to Pulmonary Tuberculosis (TB) in a person with established silicosis. The interaction between the two diseases is very damaging to the lungs.

Other reported conditions include heat stress, skin disorders, eye damage, emphysema, asthma, musculoskeletal and neurological disorders - especially damage to the hands and arms due to vibrating drills - and decompression illness associated with undersea mining. Mineworkers infected with HIV generally have low tolerances to other occupational hazards, such as heat exposure (an increasing number of heat-exhaustion cases are being reported), as well as longer recovery times after accidents (van Wyk, 2008:59).

Psychological health or well-being of mineworkers in terms of substance abuse and stress disorders are considered common. Accounts of frustration, anger, anxiety, depression, nightmares, all symptomatic of post-traumatic stress, are reported for years after involvement in or exposure to mine accidents (Frankel, 2010: xiii; Campbell, 2003:29-30). Yet the recommended textbook on mine H&S provides a comprehensive account of physical health issues, but does not mention mental or psychological health at all.¹⁰

Tuberculosis (TB)

TB is caused by a bacterium and thus has not always been regarded as an occupational disease, although it is the most common cause of illness and death in South African mining, killing more than twice as many mineworkers as occupational accidents. Between 2% and 4% of the workforce are reported to develop the disease every year (Sonica, 2006: n.p.). The highest recorded rates of tuberculosis (TB) worldwide occur in South African gold miners (Rees, Murray & Grainger, 2011:14). TB prevalence increases steadily from 806 per 100 000 in 1991 to 3 821 per 100 000 in 2004 (Rees et al., 2009a:401). Autopsies conducted on men who died working on the mines revealed that 40% suffered from TB (Bateman, 2009:852). According to the Chamber of Mines, 4 639 cases of occupational TB were reported in the industry in 2008 (COM, 2010a:129). The susceptibility of mineworkers to TB is compounded by several factors: living in close proximity, lungs weakened by dust exposure, rising drug resistance and reduced immunity due to HIV. Many studies report that exposure to dust predisposes workers to TB, even when they do not actually develop silicosis (Hnizdo & Murray, 1998; Te Water Naude et al., 2006; MHSC, 2003; Roberts, 2009:50-51). It is also well known that HIV infection increases the incidence of TB, both through the increased risk of reactivation of latent TB infection and through more rapid progression from infection to disease (Rees et al., 2009a:402).

¹⁰ See: Guild, R., Ehrlich, R., Johnston, J. & Ross, M. (Eds.) (2001). Handbook of Occupational Health Practice in the South African Mining Industry. Johannesburg: The Safety in Mines Research Advisory Committee (SIMRAC).

Among gold miners, the increase in TB case notification rates has occurred in parallel with the increasing prevalence of HIV infection, and it can be expected that TB incidence rates among miners will continue to increase during the next decade, unless effective control methods can be identified and implemented (Guild, Ehrlich, Johnston & Ross, 2001:156-157). Clinical trials for preventative drug therapy for TB are currently being undertaken in the mining industry (Fielding, Grant, Hayes, Chaisson, Corbett & Churchyard, 2011).

Silicosis and dust

The breaking and blasting of rock in mining operations inevitably results in dust, and the depth of South African mines renders dust more difficult both to control and to remove from underground. ‘Indications are that rates of occupational lung disease have risen to the same high levels that were experienced during the early part of the 20th century’ (Guild et al., 2001:122). Silicosis is the most common dust-related disease occurring in South African mining. (TB is caused by a bacterium.) Under present conditions, about one-third of all mineworkers will develop silicosis during their lifetime (Murray, 2011). There appear to have been only insignificant reductions in dust exposures, particularly in gold mining, in the second half of the 20th century (Guild et al., 2001:122). However, dust levels in mines and worker exposure to dust are complicated by many factors. Levels of dust vary between the mines, since they use a range of different ventilation technologies. Dust exposure can also vary within a single mine, at different locations, depths and times, and according to the type of work undertaken. For example, blasting exposes a worker to more dust than operating a cage (lift). Changes in worker contracts and limitations on foreign workers entering South Africa since the 1970s have meant that local mineworkers spend more months each year, and for many more years, being exposed to toxic dust:

Since the mid-1970s, however, the pattern of recruitment to the South African mines has been transformed, with the independence of Mozambique, political intervention in the release of labour from Malawi, and the toll of HIV/AIDS in neighbouring territories. This led the industry, under pressure from the apartheid state, to recruit South Africa's rural unemployed and, in its own interest in establishing a more experienced workforce, to recruit an increasing number of local Africans for longer and longer periods. The average length of a mine contract increased from 4.5 to 13.4 months. ...the mines developed a strategy of ensuring control over skilled miners through a sophisticated callback system. This has meant that the average age of the workforce also increased, an added risk factor in the contraction of occupational lung disease (Marks, 2006:572).

The longer contracts and, more importantly, the longer total time they spent on the mines exposed black miners to conditions that not only greatly increased their chances of reactivating TB infection but also greatly increased their likelihood of contracting silicosis (Packard, 1989:316). The Leon Commission also noted that mine management benefited from opportunities created by the changes in the migratory labour pattern, because a more reliable workforce was able to move away from fragmented work practices to multi-task working. The Commission reported that: 'No convincing evidence was provided to the Commission, however, that similar advantage was taken in the area of health and safety training' (Leon et al., 2004:72). The increased use of South African mineworkers has probably increased the incidence of the disease within the country's borders, rather than displacing it to neighbouring countries where it would simply be forgotten. Silicosis renders workers more vulnerable to other lung diseases, such as TB, chronic bronchitis, pneumonia and emphysema. The disease is especially sinister because, even once exposure ceases, dust particles retained within the lungs continue to be biologically active and the condition continues to develop (Guild et al., 2001:124). Silicosis is incurable, but is *preventable* if mineworkers are able to work in optimal conditions and take all necessary precautions to protect their lungs. Silicosis is therefore a definite priority focus for H&S training.

Noise-induced hearing loss (NIHL)

Hearing loss is a widespread risk for mineworkers. Research has indicated that the time-weighted average (TWA) exposure of mineworkers to noise, normalized to an eight-hour shift, is generally between 90 and 100 decibels depending on occupation. The legally recognized safe limit is 85 decibels. It is estimated that between 68 and 80 per cent of mineworkers are exposed at a time-weighted average of 85 decibels or greater, indicating a significant risk of hearing loss for the majority of the industry's personnel (Guild et al., 2001:195). The Mine Health and Safety Council (MHSC) has facilitated agreed-upon target milestones for the industry with regard to noise levels and hearing loss, which are due to come into effect between 2008 and 2013 (See later). However, mineworkers have told doctors with extensive experience in mining that they do not wear ear protection because they fear they will not hear the start of rock falls, the mine hazard they fear the most (Baskind, 2008: Personal communication), or that they may develop fungus infections in their ears (Banyini-Mulaudzi, 2011: Personal communication). Such perspectives suggest a role for more insight, rather than compliance-based training.

2.8 Small mine sector

The small mine sector warrants a special section because, though still minor in scale, it is a very fast-growing sector that appears to be especially vulnerable to lapses in health and safety. The sector is not clearly defined and ranges from informal operations, which provide subsistence living (artisanal mining), to the 'junior' companies with high turnover. It is also referred to as the artisanal small mine (ASM) sector. The South African government actively encourages the sector, as it contributes significantly to job creation. It is estimated that about 3 000 jobs can be created for every 15 sustainable small-scale mining projects given assistance (DME website, 2009). The small mine sector employs an estimated 30 000 people, compared to the 500 000 in formal mining (Hoadley & Limpitlaw, 2004:1). There is an unknown number of illegal mining operations in South Africa, many of which operate in the abandoned workings of legal mines. Illegal mining is difficult to monitor and illegal miners, due to a lack of proof, are often only charged with trespassing. Illegal mining is generally not reported to authorities.

Most illegal miners are ex-mine workers with vast experience in mining and often conspire with security and current miners who supply them with explosives (Parliamentary Communication, 2009). There are also connections between small scale ventures and BEE, as observed by Frankel:

...more worrying are the wave of BEE-driven coal-mines which have capitalised on the relatively low costs of setting up shallow coal mines in Limpopo and Mpumalanga. In many of these new operations safety standards are often primitive by any criteria (Frankel, 2010:15).

The scale of accidents in the ASM and illegal sectors are not always included in mine statistics and are only just beginning to be calculated. Fatalities due to mining incidents for the period of June 2008 to June 2009 were 142 deaths of miners lawfully employed and 135 deaths of illegal miners (Shabangu, 2009:n.p.). An illustrative example is provided by the diamond industry, where fatality rates have been increasing since early 2007. According to the Presidential Audit, the statistics from the diamond operations are most probably linked to an influx of new entrants to the diamond industry in the form of alluvial diggers, following the liberalization of the local minerals industry through the introduction of the Minerals and Petroleum Resources Development Act (MPRDA) in 2004 (DME, 2008:21). Generally, health and safety are considered to be compromised by small scale operators due to the following factors:

- Economic considerations: many of the owners use their entire income for daily living and do not invest in equipment;
- Exaggerated safety requirements that discourage them and inspire them to ignore all advice;
- Lack of hazard and risk awareness (ibid: 22).

A survey commissioned by the Mine Health and Safety Council (MHSC) reported that if data on accidents in small-scale mining are deficient, they are probably non-existent for occupational health because screening and disease-prevention programmes are rare or non-existent in that sector (Dias, Mudau, Phelane & McGill, 2007:7).

The loose management style and even the willingness to tolerate unsafe practices were important factors which contributed to the poor compliance with safety practices (Dias et al., 2007:8). The most pervasive health hazard in this sector was found to be dust, mainly because of the large number of surface operations and their location in arid regions of the country. Other specific hazards noted were:

Table 7: H&S concerns in the small mine sector	
Health	Safety
Dust	Rock falls/subsidence due to uncertain pillar design
Noise	Misuse of explosives
Exposure to mercury and other chemicals	Equipment obsolete, poorly maintained and inappropriately adapted
Poor or no ventilation (heat, humidity, lack of oxygen)	Lack of personal protective equipment (PPE)
UV radiation due to surface workings	Climbing shafts (up to 90 m deep) using handholds/footholds or rope
Heat exhaustion due to inadequate space and inappropriate equipment	Use of torches attached to helmets in absence of electricity.
No ablutions for hygiene/washing off toxic substances.	

(Source: Dias et al., 2007:4-7)

Most of the recommendations of the survey relate to development of the efficacy of operators or workers:

- To develop guidelines/guidance specifically for the small-scale mine operator that would take into account the special requirements and limited resources of small-scale mines, when compared to those of larger mines;
- To determine training needs and provide training to small-scale mine operators; and
- To have a database of all relevant handbooks on occupational hygiene measurements and the interpretations of these measurements, and have these translated into one or more African languages (ibid: 14).

The very fast-growing small mine sector provides employment for retrenched mineworkers, with encouragement from the South African government. However, the sector falls beneath the radar of formal H&S monitoring.

Efforts to enhance the H&S efficacy of individual mineworkers may have some impact if and when they move into the small mine sector, while other regulations and policy directives do not really reach this sector.

2.9 Policy and legislation

Mine Health and Safety Act (MHSA)

South Africa has substantial H&S legislation. The most far-reaching legislation, the Occupational Health and Safety Act (OHSA) 85 of 1993, applies in all contexts except mining, which has its own dedicated legislation. The OHSA is administered by the Department of Labour. In special circumstances, the Minister of Minerals Resources may make specific applications of the OHSA applicable to a mine after consulting with the Mine Health and Safety Council (See Section 80 of the Mine Health and Safety Act). Mines and other mining locations, such as quarries, fall under the auspices of the Mine Health and Safety Act (MHSA) 29 of 1996 and Amendment Acts 72 of 1997 and 74 of 2008, administered by the Department of Minerals Resources.¹¹ An explanation for the sector-specific legislation follows:

The South African mining industry is characterised to a large degree by the anomaly of huge technological developments accompanied by a largely unskilled or semi-skilled workforce. This combination, apart from the nature of mining itself, increases the scope of occupational hazards significantly enough to merit health and safety legislation distinct from that which governs the rest of South African industry (Joubert, 2007:406).

The MHSA aims to protect employees and other persons at mines and to promote a culture of H&S. It is extensive in its focus and provides not only for the enforcement of measures but also for participation of employees, employers and the state in H&S in the form of representative tripartite institutions (state, industry, labour).

¹¹ From this point onwards the Mine Health and Safety Act 29 of 1996 and Amendment Acts 72 of 1997 and 74 of 2008 will collectively be referred to as MHSA.

Tripartite representatives should review legislation, enhance research and effective monitoring systems and promote training and human resource development to improve H&S (Joubert, 2000:265-266). Specific regulations in the Act relate to different mining functions, such as those involving electricity, explosives, machines and transport. The powers, duties and rights of the different stakeholders, from the Minister of Minerals Resources, to employers, chief executive officers (CEOs), managers, inspectors, health and safety representatives, and employees, are also outlined. The sections of the MHSA most relevant to this study are those which relate to training and affect 'every employee', rather than managers or other officials (MHSA, Chapter 2).¹² Education and training in the mining sector are dealt with in detail in Chapter 5. All mineworkers are legally empowered to use their own judgement/self-efficacy when faced with H&S risks and voluntarily to leave a work site that they regard as unsafe or unhealthy (MHSA, Chapter 2, Section 23). An employee has the right to leave the workplace if and when circumstances arise that 'with reasonable justification, appear to that employee to pose a serious danger to the health or safety of that employee'. However, anecdotal reports indicate that workers find it difficult to interpret 'reasonable justification' for walking out and fear losing their employment, or losing good employment, if their reasons for walking out are later found to be invalid.

¹² **MHSA, Chapter 2, Health and Safety at Mines, Section 22**

Every employee at a mine, while at that mine, must

- a) take reasonable care to protect their own health and safety;
- b) take reasonable care to protect the health and safety of other persons who may be affected by any act or omission of that employee;
- c) use and take proper care of protective clothing, and other health and safety facilities and equipment provided for the protection, health or safety of that employee and other employees;
- d) report promptly to their immediate supervisor any situation which the employee believes presents a risk to the health or safety of that employee or any other person, and with which the employee cannot properly deal;
- e) cooperate with any person to permit compliance with the duties and responsibilities placed on that person in terms of this Act; and
- f) comply with prescribed health and safety measures.

The legislation also requires the election of H&S representatives for internal monitoring; and the deployment of inspectors for external monitoring of compliance with the MHSA. These two systems are discussed below.

Compliance and monitoring

Two statutory bodies assist the Minister of Minerals Resources in monitoring and enforcing H&S compliance: the Mine Health and Safety Inspectorate (hereafter, 'the Inspectorate') and the Mine Health and Safety Council (MHSC).

The Inspectorate is a section within the Department of Minerals Resources (DMR), under the leadership of the Chief Inspector of Mines. Inspectors operate from regional offices with almost unlimited access to mine property. They are empowered with immediate and far reaching powers and are able to impose fines and to limit or shut down mine operations.¹³ However, there is a nation-wide lack of skilled people to do such work in the competitive local labour market, with more attractive remuneration in the private sector. Candidates trained within the Inspectorate soon move on to the private sector (DME, 2008:40-41). The Inspectorate has a vacancy rate of 29%, and a number of these vacancies have been advertised repeatedly without attracting any suitable candidates (ibid: 42). The future capacity of the system of inspectors is also not assured: 'It appears that the inspectorate will continue to struggle with recruitment and retention and the subsequent lack of capacity' (ibid: 44).

¹³ In the course of their work, inspectors may:

- enter any mine at any time without warrant or notice;
- question any person on any matter;
- examine any relevant document and make a copy of it or take an extract from it;
- inspect arrangements made by the employer for medical surveillance of employees;
- seize any document, article, substance or machinery or any part or sample of it.

An inspector may issue fines, limit or shut down workings on a mine where a person's death, serious injury or illness to a person or a health threatening occurrence has occurred.

(Source: MHSA, Chapter 5, Sections 47-50.)

Other research points to a lack of funding in the Inspectorate from the government: ‘The government was blamed in consequence, because without proper monitoring of the legislative mechanisms, it would be impossible to check if companies were complying with mining safety regulations’ (Eweje, 2005:171).

The Chief Inspector of Mines is also the chairman of the Mine Health and Safety Council (MHSC), a statutory body made up of equal representation of state, employer and organized labour. The primary function of the MHSC is to advise the Minister of Minerals Resources about mine H&S, especially in terms of policy. Three permanent committees of the MHSC focus on research, legislation and monitoring (MHSC, 2009a:4). According to the Minister of Minerals Resources, the mining industry has achieved an overall score of 66% compliance with MHSA (ibid:5). A number of variables were assessed and health risk management was reported to have the lowest score. Compliance scores, averaged across the sector for different commodities and regions, produced the following results:

Table 8: MHSA compliance scores across sector			
Highest %		Lowest %	
Legal appointments	75	Codes of Practice	62
Mine water management	72	Occupational H&S policy	59
Mine design	70	Health risk management	56

(Source: DME, 2009a:n.p.)

Other policy developments

The MHSC also facilitates consensus towards targets and milestones for mine H&S. At a summit in 2003, tripartite stakeholders (state, employer, labour) agreed to targets with regard to fatalities and injuries and the elimination of silicosis and noise-induced hearing loss. Milestones, or intermediate steps to the targets, are to be attained by the industry over a ten-year period from 2003 to 2013. They are presented in the next table.

Target	H&S milestones for 2013
Zero rate of fatalities and injuries	Achieve safety performance levels in line with international standards Ensure continuous improvement
Eliminate Silicosis	Ensure 95% of all exposure measurement results will be below the occupational exposure limit for respirable crystalline silica of 0.1 mg/m ³ by 2008 Ensure no new cases of silicosis occur
Eliminate Noise-Induced Hearing Loss	Ensure that no hearing deterioration greater than 10% occurs amongst occupationally exposed individuals; Ensure the total noise emitted by all equipment installed in any workplace does not exceed a sound pressure level of 110 dB
Prevention of HIV Aids	Ensure that employees receive education on HIV and Aids to ensure that the rate of HIV and Aids is drastically reduced in the mining and minerals sector

(Source: MHSC, 2009a:2)

Current trends in available data indicate that local mining is not achieving the level of improvement needed to reach the milestones (Hermanus, 2007:535; Frankel, 2010:17). Consequently, stakeholders in the sector formulated a Tripartite Action Plan on Health and Safety in 2008, presented below:

Strategic goal	Action
Strengthen the culture of H&S	<ul style="list-style-type: none"> • Implement a culture transformation framework
Promote learning from best practice	<ul style="list-style-type: none"> • Establish a MOSH learning hub to promote the adoption of leading practices
Build capacity in H&S	<ul style="list-style-type: none"> • Train 40000 H&S representatives and union shop stewards • Develop a strategy to train and retain OHS professionals
Improve R&D	<ul style="list-style-type: none"> • Establish a centre of excellence of mine H&S

(Source: COM, 2010a:129)

It is not clear why the targets set are not being reached. Perhaps they were too ambitious, or possibly the methods, systems and technology required for the necessary changes were and are not in place. Frankel (2010) suggests that ‘worker engagement’ with H&S would be a more functional goal:

This is perhaps a far more important milestone to reach than the zero-harm identified for 2013 by the industry. Indeed, as evidence shows irrevocably, zero-harm cannot be achieved, least of all maintained, unless it is preceded by employers moving beyond mere conversation to genuine mutual involvement with their employees. This involves, at baseline, equipping labour with self-efficacy based on meaningful work (Frankel, 2010:32).

Much is made of partnerships for health and safety in the mining industry, and there are numerous summits involving the state, industry and the trade unions. Such stakeholder partnerships and agreements are integral to policy development in the new South Africa. They appear to have the advantages of being inclusive, providing a range of ideas and comprehensive logistical support for initiatives, creating a form of ‘new governance’:

The new governance: An increasing reliance on multi-stakeholder initiatives, networks, or partnerships for the purpose of policy-making and/or implementation. Hence, new governance has often been defined as the shift of policy- and decision-making power and responsibility from the state towards more dispersed, collaborative networks of social actors (Hamann, Khagram & Rohan, 2008:22).

However, the primary reliance on stakeholder consultation for policy development and planning of education and development programmes is questioned in terms of realism and the utility of the policy produced, as opposed to simple endorsement (Jansen, 2002:207; Campbell, 2003:181; Hamman et al., 2008:23). The dispersal of vision and responsibility and the unequal power of different stakeholders, in reality as opposed to the ideal, are raised as cautions. In fact, the different mining stakeholder representatives, especially those representing industry and providers of training, are often intense competitors in the market place. The H&S record of large companies has some influence on foreign investment in individual companies. Even once goals are agreed upon, there may still be inadequate conceptualization of how to achieve them. Nor is there always systematic accountability among the different partners. This is not necessarily the case in the H&S goals set, but it is an issue to consider in the formulation of future policy and initiatives.

Health and safety representatives

Health and safety support for workers, ongoing and on-site, is ideally offered by health and safety representatives. Every mine with 20 or more employees is compelled to have an H&S representative, elected by workers, for each shift at each designated working place in the mine.¹⁴ In principle, the H&S representative system is a positive intervention, because it has extensive reach across the sector and provides direct connections to the most vulnerable workers, but the system is still unfolding and representatives may still lack power and credibility in the workplace, as is evidenced in the following quote from the biggest trade union operating in the sector:

The Mine Health and Safety Act, among other important rights, entrenches the right to refuse dangerous work. The Act also formalises the election of health and safety representatives by workers to participate in health and safety committees. But these representatives are unable to exercise these rights: their opinions are overlooked and they have no influence in exercising discretion on the danger of mining terrains (Baleni, 2007:2).

Compensation

The legislation governing compensation is not overtly designed to influence health and safety behaviour in mines. However, many critiques of the existing legislation declare that it places limited financial pressure on employers to ensure the H&S of workers and contributes to its low priority.

¹⁴ Representatives may not be responsible for more than 100 workers in a single workplace or more than 50 workers if the designated workplace includes separate working places. The representative must be employed in a full-time capacity in the designated working place. A few of the stated functions and tasks of H&S representatives are listed below:

- Represent employees on all aspects of health and safety;
- Identify potential hazards and risks to health or safety;
- Inspect working places with regard to the health and safety of employees at intervals agreed with the employer;
- Make representations or recommendations to the employer or to a health and safety committee on any matter affecting the health or safety of employees;
- Direct any employee to leave any working place whenever circumstances arise that with reasonable justification appear to pose a serious danger to the health or safety of that employee

(MHSA, Chapter 3, Sections 25-30).

The nature and functioning of local compensation legislation, especially the Occupational Diseases in Mines and Works Act of 1973 and the Amendment Act 60 of 2002 (ODMWA), have been found to displace the burden of disease onto rural communities when sick mineworkers return home after receiving the one-off payments required in terms of the Act:

No investigation of the equity of the ODMWA compensation system has been done before. It is posited that it is a discriminatory system that is a cheap form of compensation which serves as a subsidy to the mining industry in that it externalizes the costs of occupationally acquired lung disease. The labour sending communities which provide large numbers of migrant mineworkers to the mining industry are likely to have a high prevalence of silicosis and silico-tuberculosis which would have a severe social impact, intensifying deprivation and poverty amongst former mineworkers and their families, as well as within their communities (Roberts, 2009:12).

This view explains structural lapses in health and safety in the workplace; however, this is a topic for another thesis. The legislation is outlined briefly here, with regard to how it may be referred to in this study. Two statutes regulate the compensation of workers for workplace injuries and occupational diseases. The Compensation for Occupational Diseases Act 130 of 1993 (COIDA), administered by the Department of Labour, provides for payment of medical treatment, periodical payment for workers with a temporary disability, and lump-sum or pension payments to permanently disabled workers. The ODMWA is administered by the Department of Health and compensates workers in mines and works for respiratory diseases. Financial benefits under ODMWA are limited to lump-sum cash benefits. The existence of a separate compensation system can be traced to legislation regulating lung diseases in the early years of the mining industry. A decision to merge the two compensation systems was made in 1996, but has not yet been implemented.

2.10 Conclusions

This overview of mine health and safety in South Africa suggests a policy-practice divide. The legislation is comprehensive, but implementation and compliance are limited. Mine health and safety statistics, reports and anecdotal evidence reveal a comparatively poor safety record and a dire health situation, considered in the light of the extensive legislation. Aspects of the legislation, which should affect underground workers directly, such as training (see later), the representative system and the inspectorate are still developing or lack capacity. The reasons for poor achievement are many and complex. Mine H&S policy development may have been subject to the same constraints as other stakeholder-defined policy processes in South Africa - a lack of accountability between 'equal' stakeholders and a dispersal of vision and responsibility. Mine safety is improving over the long term in the formal mining sector, and the MHSA is valuable in providing a sound policy and legal framework for standards, surveillance and initiating changes. However, it is virtually impossible to monitor compliance in a sustained way in a tunnel that is one metre wide and four km underground. (Narrow tunnels are less likely to collapse than those that are wider.)

H&S may be more assured by focusing on those whose efficacy is essential to their safety - underground workers at the end of the chain of command who comprise about 73% of the total mining workforce. The acknowledged neglect of occupational health in the context of terrible occupational disease (and increasing lung disease) suggests an urgent priority for H&S policy, practice and training. Adherence to and compliance with standards may be acknowledged by large employers operating within South Africa. However, the increasing number of small mines and contract workers suggests that an increasing number of mineworkers will fall outside of safety networks and surveillance. New policy and practice developments may be required.