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A systems approach to accident causation in mining: An application of the HFACS method

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ABSTRACT

This project aimed to provide a greater understanding of the systemic factors involved in mining accidents, and to examine those organisational and supervisory failures that are predictive of sub-standard performance at operator level. A sample of 263 significant mining incidents in Australia across 2007–2008 were analysed using the Human Factors Analysis and Classification System (HFACS). Two human factors specialists independently undertook the analysis. Incidents occurred more frequently in operations concerning the use of surface mobile equipment (38%) and working at heights (21%), however injury was more frequently associated with electrical operations and vehicles and machinery. Several HFACS categories appeared frequently: skill-based errors (64%) and violations (57%), issues with the physical environment (56%), and organisational processes (65%). Focussing on the overall system, several factors were found to predict the presence of failures in other parts of the system, including planned inappropriate operations and team resource management; inadequate supervision and team resource management; and organisational climate and inadequate supervision. It is recommended that these associations deserve greater attention in future attempts to develop accident countermeasures, although other significant associations should not be ignored. In accordance with findings from previous HFACS-based analyses of aviation and medical incidents, efforts to reduce the frequency of unsafe acts or operations should be directed to a few critical HFACS categories at the higher levels: organisational climate, planned inadequate operations, and inadequate supervision. While remedial strategies are proposed it is important that future efforts evaluate the utility of the measures proposed in studies of system safety.

Epidemiological studies have shown that mining workers face a relatively hazardous work environment compared to workers in other industries. For example, the rate of fatal injury for mining workers was between 7 and 10 times that of the average worker in the population in the United States, Australia, and New Zealand (Feyer et al., 2001). In addition to the inevitable pain and suffering, the financial cost of medical care and lost productivity due to injury in mining is considerable. In a US-based analysis from 1993, lignite and bituminous coal mining was ranked second in terms of average cost per worker for fatal and non-fatal injuries (Leigh et al., 2004). These data reinforce the need for further efforts to understand the factors shaping injury to mine workers.

Contemporary human factors approaches to system safety have been used to provide greater insights into the causes of accidents in many safety-critical domains and can be applied to the mining context. These models of human error in organisational systems take a systems approach, noting that accidents can be attributed to a combination of active operator-level errors and inadequate, or latent, conditions that reside throughout the system (Reason, 1990, 1997). Such models have underpinned the development of several methods of accident investigation and analysis that use error and latent condition classification schemes to provide an analysis of the types of failure involved in accidents. One of the more widely used approaches is the Human Factors Analysis and Classification System (HFACS; Wiegmann and Shappell, 2003) which has featured in the analysis of safety data in many recent publications within this journal (Celik and Cebi, 2009; Li et al., 2008; Olsen and Shorrock, 2010; Reinach and Viale, 2006).

When analysing cases, the first step involves identifying the unsafe acts involved (HFACS Level 1). Since HFACS uses taxonomies of external error and failure modes, this involves using the data available to classify any errors or violations that were made by front line workers (e.g. pilots, miners) that led to the accident occurring. Within the errors category the following three basic error types are

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