Improving Safety Through Better Equipment Design: A Global Industry Project

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Abstract

Most fatalities in the Australian mining industry involve equipment operation or maintenance. Causal factors include behaviour, the work process and equipment design. The latter is the focus of this activity. In March 2006, three mining companies met to discuss approaches to engaging with surface mining equipment Original Equipment Manufacturers (OEMs) about improving equipment design. ACARP also funded a 2006 project to examine human factors engineering in the design of large surface mining equipment. The multi-company initiative and the ACARP project were combined in mid 2006.

The Earth Moving Equipment Safety Round Table (EMESRT) was formally established in the 3rd quarter of 2006 with six member companies and a Terms of Reference. The member companies for 2006 were Anglo American, BHP Billiton, Newmont, Phelps Dodge, Rio Tinto and Xstrata, with Barrick joining in early 2007 with the potential for expansion in the future.

The project involves engaging with OEMs, initially haul truck OEMs, to speak with "one voice" about H&S equipment design issues. In 2006 the six companies met with six OEMs at their North American offices to initiate the engagement though establishing the issues, providing two major areas of need (access/egress and falls from height) and challenging the OEMs to define a potential productive engagement process with EMESRT. The OEM response to these meetings was used to guide development of the 2007/2008 EMESRT action plan.

Fifteen human factors issues have been identified as priority areas for 2007 and 2008. Development of the eight priority design philosophies for 2007 is being championed by focus leaders drawn from the EMESRT member group. EMESRT will also engage the OEMs in other areas such as the development of Operability and Maintainability Risk Assessment methodology to assist with the systematic review of new equipment design. MISHC is assisting with gathering input on design requirements, reviewing related ISO standards, and sourcing information about events or incidents related to the relevant design philosophy.

This presentation will briefly overview the history and nature of EMESRT and the progress made to the present time.

Introduction

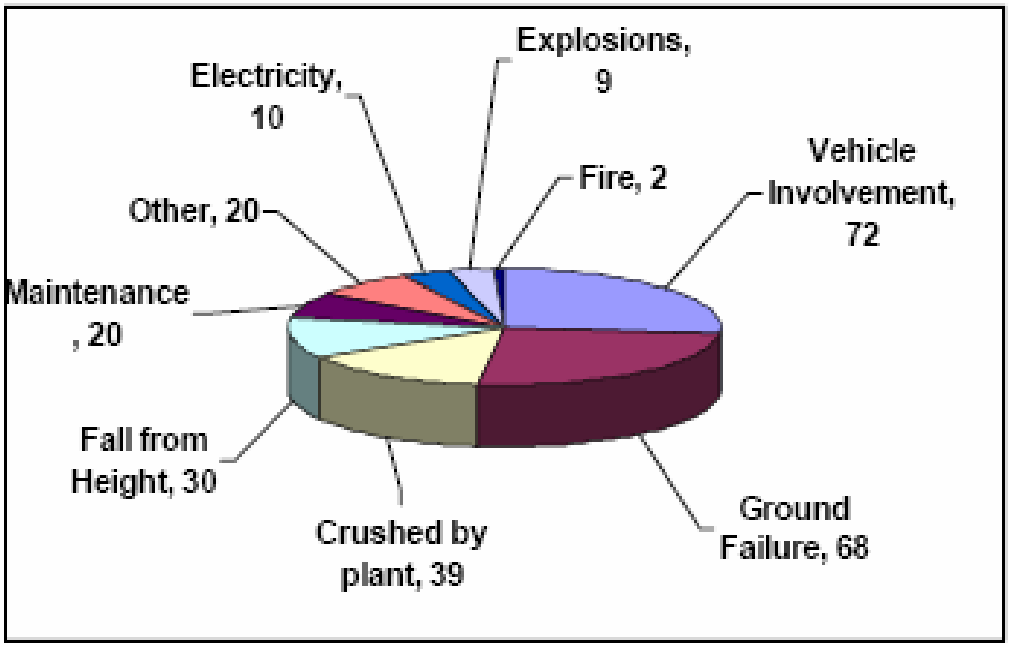
To stand back and take a hard look at today's modern large mining equipment, it is relatively unchanged in the past 30+ years. Sure the size of mining equipment has increased with advances in tyre technology, engines, control systems and drive systems but how else has the mining equipment changed? Haul trucks have 2 axles on today's 400 ton units as did the

170 ton trucks in the late 1970's. Graders are still tandem axle units. Dozers tend to have cabs with ROPS now. Despite some excellent work in some areas many of the human factors design issues for mining equipment of 30+ years ago remains today.

Background

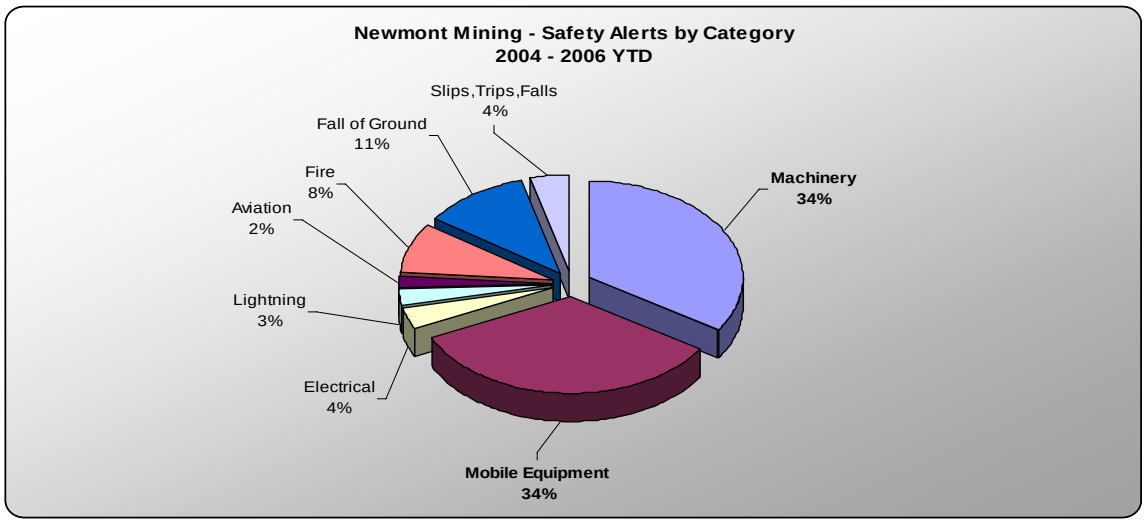
Fatalities in any industry are not acceptable with most fatalities in the mining industry involving equipment operation or maintenance. Figure 1 shows the profile of fatal incidents in the Australian minerals industry (source: *The MCA* [Mining Council of Australia] *Mobile Equipment Incident Causation Survey 2005-6*) with 27% of fatalities related to vehicle involvement.

Figure 1-Profile of Fatal incidents in the Australian minerals industry 1990 to 2004



Accident and incident data from Newmont Mining Corporation and other large mining companies shows similar trends to the findings in Australia noted above therefore changes need to be made on all fronts. Figure 2 shows Mobile Equipment accounts for 34% of Newmont's Significant Incidents for 2004 – 2006.

Figure 2-Newmont Mining Corporation Significant Incidents 2004—2006.



Mining companies face a common problem ensuring that earth moving equipment is designed to be operated and maintained under all site conditions without causing harm to people. Mine accident data has clearly implicated poor human factors design issues in fatalities, injuries and illnesses associated with earth moving equipment incidents, such as collisions with light vehicles, isolation problems, falls from heights, loss of control and factors such as fatigue, noise and dust.

EMESRT…..the story so far

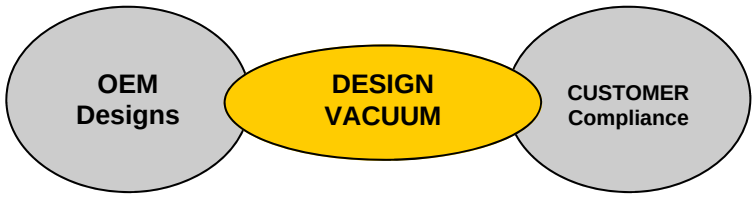
The suggestion of a joint customer approach to improve Human Factors design of Earth Moving Equipment (EME) was first mooted by some Australian mining companies in 2004. Some OEM's encouraged such a movement so that they could sort through what they saw as the mixed messages coming from their customers. The idea gradually gathered momentum, and in March 2006, the first official meeting to discuss a new multi-company initiative took place at Bulga in NSW, involving representatives from Xstrata Coal, BHP Billiton, Anglo Coal and MISHC. Rio Tinto officially joined the group in April 2006, with Phelps Dodge and Newmont joining in August 2006. Barrick, the newest member of the group, joined in late 2006 following meetings with the major manufacturers of earth moving equipment.

The Minerals Industry Safety and Health Centre (MISHC) was invited to facilitate and coordinate this innovative engagement process. Jim Joy, Professor of Risk Management at MISHC, and project leader of the Australian Coal Association Research Program (ACARP) funded research project "Improvement of Human Factors Engineering in Large Surface Mining Equipment Design" also brings considerable Human Factors (HF) expertise to the MISHC component of EMESRT.

The EMESRT initiative was consistent with the intent of this ACARP project, prompting agreement by ACARP to provide additional funding for MISHC to assist EMESRT with the critical development phase of the OEM engagement process. ACARP also agreed to provide funding for the dissemination, via MIRMgate (www.mirmgate.com), of information about leading practice designs and issues that have prompted the development of EMESRT design philosophies.

Design gap

Despite the fact that earth moving equipment is generally designed to recognised international standards, human factors design aspects often fail to meet customer requirements for compliance with both company and regulatory standards, as well as controlling risks to 'As Low As Reasonably Practicable' (ALARP). This has created a gap or 'design vacuum' between OEM designs and customer needs, which allows inadequate opportunity for identifying and managing residual risks that may exist. Over time, dealers have attempted to fill this vacuum by retrofitting customer driven solutions, which has created new issues. Redesign is not a core business area for most dealers, who generally lack appropriate design resources. The need for redesign also creates a long lead-time to users, resulting in higher costs to the customer.



Design Philosophies

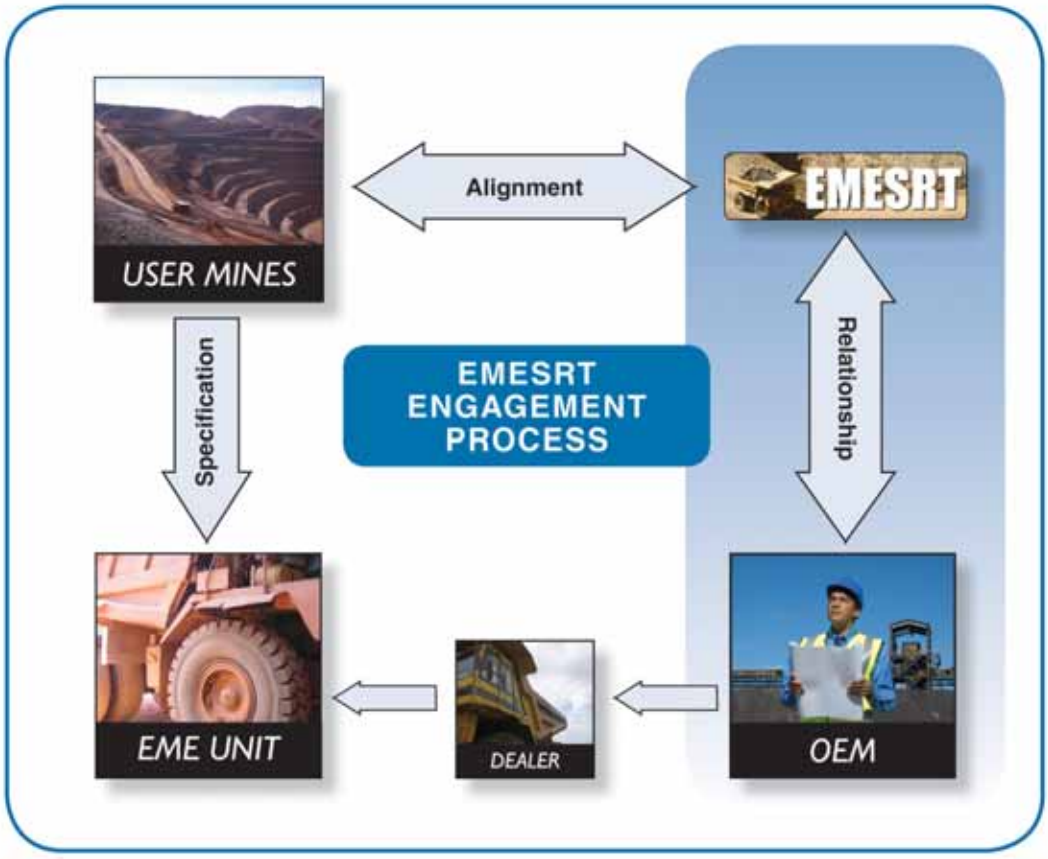
EMESRT members agreed that their ability to align company requirements and expectations for human factors design would be critical for presenting a 'common voice' to OEMs. This need has led to the development of design philosophy sheets that present an aligned viewpoint on objectives, general design outcomes and risks to be mitigated. These sheets are supported pictorially by images that depict both the problem and leading practice example solutions developed by companies and third parties. The aim of a Design Philosophy is to provide information to help the OEM design equipment with risks reduced to an acceptable level. Design philosophy sheets for "Access & Egress" and "Working at Heights" were discussed with the OEMs in late 2006 and proved a useful tool for demonstrating the issues concerning EMESRT.

Fifteen topics have been identified as priority areas for 2007 and 2008. Development of the eight priority design philosophies for 2007 (topics in **bold** in the table below) is being championed by focus leaders drawn from the EMESRT member group. Champions intend to utilise company and other resources to enhance the accuracy and validity of their selected topic. MISHC will assist with gathering input on design requirements, reviewing related ISO standards, and sourcing information about events or incidents related to the relevant design philosophy. EMESRT will also engage the OEMs in other areas such as the development of Operability and Maintainability Concept Risk Analysis methods.

1. **Access & Egress**
2. **Working at Heights**
3. Noise
4. **Vibration**
5. **Fire**
6. Dust
7. **Isolation**
8. **Visibility / collision detection**
9. Machine stability / slope indication
10. Guarding
11. Displays, controls, including labelling
12. **Tyres & Rims**
13. **Manual materials handling**
14. Work postures
15. Confined space

Engagement Process

EMESRT has initiated an engagement process (graphically depicted below) aimed at establishing an effective relationship between EMESRT and OEMs. The intent of this engagement process is to create a platform for communicating the "problem" to the OEMs and providing them with an avenue for developing a "solution" built on design feedback from site users. The success of this culture change in the way OEMs and companies communicate and engage is paramount to the improvement of earth moving equipment design. EMESRT has also agreed to work towards educating user mines about the design philosophy aims and to encourage use of the design philosophies in the purchasing process for new earth moving equipment (EME).



Meetings in late 2006 with representatives from Terex, LeTourneau, Liebherr, Hitachi, Komatsu and Caterpillar, delivered useful feedback and ideas for determining the future role of EMESRT. These have been incorporated into the 2007 work plan.

The key aspects of this plan are to fully develop the design philosophies for the eight topics nominated for 2007, and to disseminate information about these design philosophies to OEMs and the global minerals industry. MISHC is assisting this process by compiling related information and making it available via an EMESRT Alert Service which is due for release in late June 2007. This Alert Service will notify MIRMgate users when new information related to any of the 15 design philosophies is released. Information about incidents, innovations, research and other good practice resources is being sourced for this purpose. Information about how to register for EMESRT alerts is available at www.mirmgate.com.

In 2007 EMESRT will design and communicate a systematic process of reviewing new equipment design, ideally in early stages, to optimise human factors in operability and maintainability. This systematic process will be designed to clearly link to the EMESRT design philosophy information and be easily documented. The outcomes will assist OEMs to demonstrate a reasonable approach to good human factors design and help site users to identify good design to be incorporated into their purchasing specifications.

The initial phase of EMESRT / OEM engagement has been widely communicated through a number of media outlets, including newsletters, journal articles, websites and presentations at conferences and other face to face forums. MISHC is keen to hear from interested parties who have a specific interest in one or more of the design philosophies.

Further engagement with the leading manufacturers of earth moving equipment is planned for late 2007. The current focus of EMESRT is on improving the design of earth moving equipment operating on the surface at mines. It is likely that this could be extended to other areas once the engagement process has been fully developed and demonstrated success.

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