EMESRT

Earth Moving Equipment Safety Round Table

# ANNUAL REPORT 2017

*Working with industry since 2006*

emesrt.org

# INTRODUCTION

The Earth Moving Equipment Safety Round Table (EMESRT) is a global health and safety by design initiative. It was established in 2006 to fill the design gap between customer and equipment designer expectations.

At that time, mining companies were routinely installing significant and costly after-market modifications to their mining fleets and it was recognised that if Original Equipment Manufacturers (OEM's) better understood the operational and maintenance risks from the customer perspective, then factory level solutions could be developed for the benefit of all parties.

Twelve years later, we continue to coordinate the delivery of industry-level resolutions to common problems through design and we do this by working with communities of equipment users, OEM's, researchers and third-party suppliers.

We operate as a fully industry-funded entity, with expert members who currently represent seven major mining companies. Together we present a common industry voice, with a clear vision and purpose.

We apply a methodology that uses operational scenarios to frame and define problems, and this gives design specialists a deep understanding of what equipment end users need.

This approach accelerates the development of innovative and market ready solutions, and avoids the limiting step of multiple end users preparing their own solution-based specifications to close the design gaps.

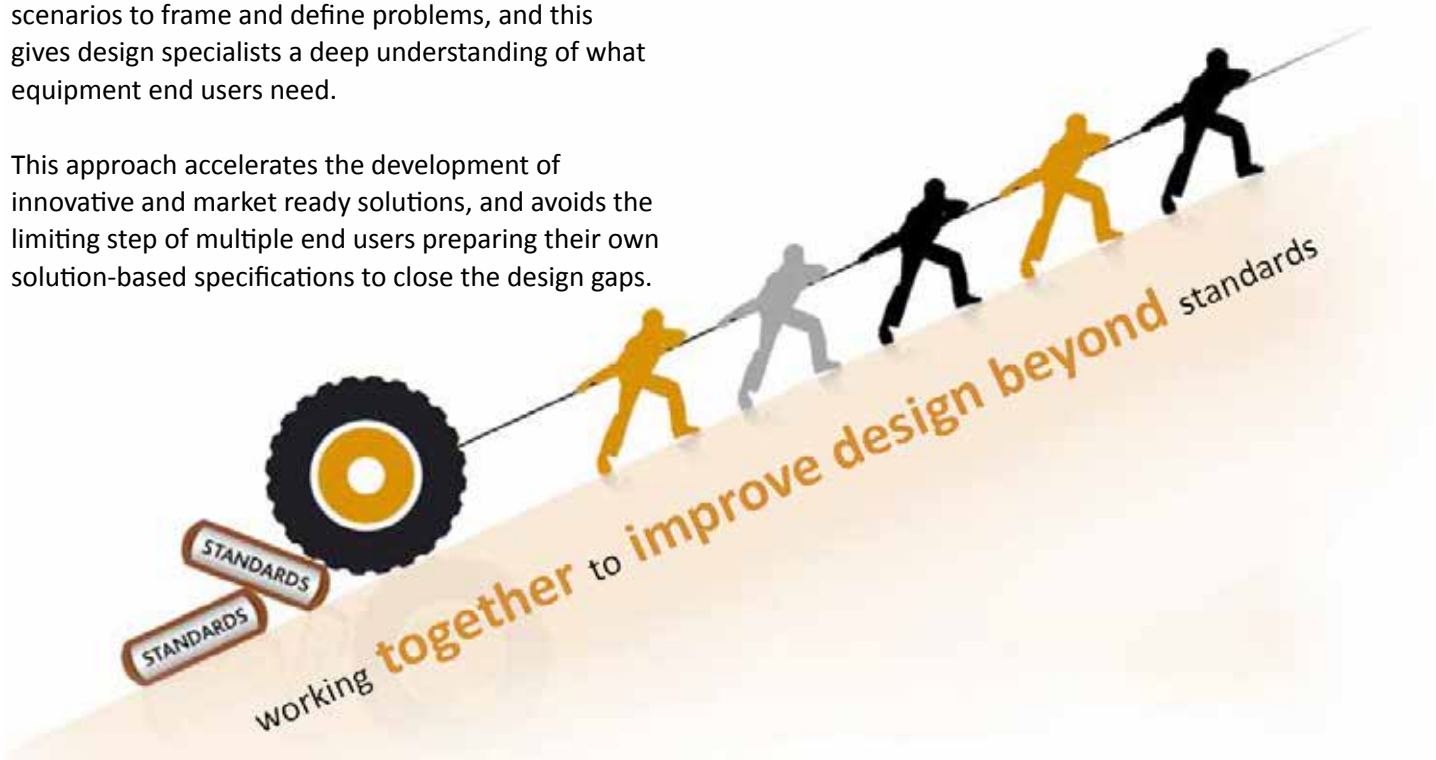
These principles guide our work:

- Designing beyond standards
- Balancing engineering and behaviour (human factors)
- Recognising the value of task-based design review
- Appreciating that the Original Equipment Manufacturer (OEM) does its best with the end user involved
- Open genuine two-way engagement is vital

EMESRT is a strong industry brand that is recognised and accepted by global OEM's and other stakeholders. Our history is described in more detail later in this report.

Throughout 2017, we have continued to engage, influence and facilitate the delivery of real world business outcomes that improve health and safety when operating and maintaining earth moving equipment.

This report details how we apply our methodologies, connect and sustain a community, and coordinate the delivery of clear problem definition information to designers and users, to enable practical improvements for our industry.



# OUR VISION

A mining industry free of fatalities, injuries and occupational illnesses associated with operating and maintaining earth moving equipment.

# OUR PURPOSE

Accelerate development and adoption of leading practice designs to minimise the risk to health and safety through a process of Original Equipment Manufacturer, contractor and user engagement.

# OUR MEMBERS

Alcoa

AngloAmerican

BARRICK

GLENCORE

NEWCREST MINING LIMITED

Peabody

RioTinto

# ADVISORY GROUP STATEMENT

In 2006, EMESRT was established to accelerate the development and adoption of leading practice designs, to minimise the risk to health and safety associated with operating and maintaining earth moving equipment. Our purpose is as relevant now as it was then.

While we can point to real success in design changes that have largely eliminated vehicle access/egress and working at heights injuries over the last decade, many complex challenges remain.

Today, the most pressing challenge facing the mining industry is to improve controls for managing mobile equipment operation and driving risks. Each year, between 30 and 40 percent of industry fatalities are attributed to failure of vehicle interaction controls and around half of these involve pedestrians.

Since 2013, EMESRT has facilitated an industry-level vehicle interaction dialogue with the goal of improving the reliability of vehicle interaction controls in mining. The initial project focus was on developing awareness, advisory and intervention technologies. However, after recognising that vehicle interaction controls are multi-level, interconnected and dynamic, the project now also considers how innovations in mine design and mine operational controls can be better supported with technology along with identifying and sharing good practice.

Since its inception, EMESRT's relationship with the International Council on Mining and Metals (ICMM) has operated at varying levels. During 2017, based on common company memberships and overlapping missions, we invited the ICMM to collaborate with us to improve vehicle interaction controls in mining.

For this project, an early indicator of project success will be when:

- Site leaders across our industry have the necessary resources to deeply understand their specific vehicle interaction circumstances and can make informed decisions about the controls that are the most appropriate for their operational situation
- Vehicle interaction controls are clearly specified, fully implemented, and then maintained, monitored and routinely verified as part of normal operations
- Adequately proven technology enhances existing control performance and/or replaces weak existing controls

This report provides the details of the significant project progress made during 2017, along with next-steps planning.

As advisory group members, we acknowledge the significant financial input from our respective member companies and their ongoing support for our contributions. On their behalf, we are committed to sustaining and improving EMESRT.

In 2017, we achieved these outcomes:

- Increased the number of member companies
- Expanded the vehicle interaction project community membership
- Accelerated formalising of EMESRT processes and capturing member experience, noting that a core of EMESRT Advisory Group (EAG) members have been involved since 2006
- Reviewed the 2–5 year planning horizon
- Welcomed new member company representatives to the EAG.

To ensure EMESRT remains relevant, we also reviewed our performance over the last decade and benchmarked with similar sector leading international organisations (see Appendix I). This strategic review confirmed five success factors for EMESRT:

1. Working with an industry-level focus
2. Having a real-world business understanding of financial drivers and leverage that enable investment in design improvements
3. Understanding that innovation is market-driven, not pushed by technology
4. Good governance processes to cover structure, funding, risk management, renewal and continuity
5. Senior management (decision maker) endorsement

These five factors are used to structure this report and will contribute to the continued success of EMESRT. The intended audience for this report is:

- EMESRT member companies, both specialists and senior leaders
- Earth moving equipment OEM organisations
- Third party providers, particularly of Proximity Detection Systems (PDS)
- All participants of EMESRT working groups
- Other industry organisations with overlapping missions and memberships
- Non-EMESRT member mining companies and contract mining organisations
- All other interested parties

We hope you will find the report informative, useful and enjoyable.

*EMESRT Advisory Group*
March 2018

# CONTENTS

# WORKING AT AN INDUSTRY LEVEL

EMESRT member companies represent a significant share of the global annual earth moving equipment spend. Through EMESRT, these companies gain leverage and influence at an industry scale and avoid project duplication when addressing common issues. EMESRT also provides an industry level 'corporate memory' with access to resources, experience and expertise.

Key to the EMESRT approach is industry-level engagement with industry OEM's, to fill the knowledge gap between the customers and the equipment designers.

Taking this approach helps OEM's develop an understanding of operational and maintenance risks from a customer (user) perspective – making rapid advances in equipment design, beyond standards, a possibility. The practical reasons for adopting this approach are:

- The design gap between OEM's and users required a change – from stipulating solutions to clearly articulating the user's problems so designers could improve designs
- Only the OEM can shrink the design gap that third party suppliers create businesses to fill
- Marketing controls the Research and Development (R&D) spend, so only working through engineers does not motivate the business case for investing in changes for OEM designs
- A 'common industry voice' approach to defining problems, not solutions, provides a business case for marketing to fund R&D

This approach has been developed since 2006 and after an initial trust building period, EMESRT has established a mature 'common voice' engagement process between OEM's and mining customers, while continuing to work with other stakeholders, see Figure 1.

EMESRT is successful at an industry level through a combination of relationships and the application of these principles. For each problem topic, key industry people are invited to be involved and the principles provide a common direction. The detailed approach applied is issue specific and flexible.

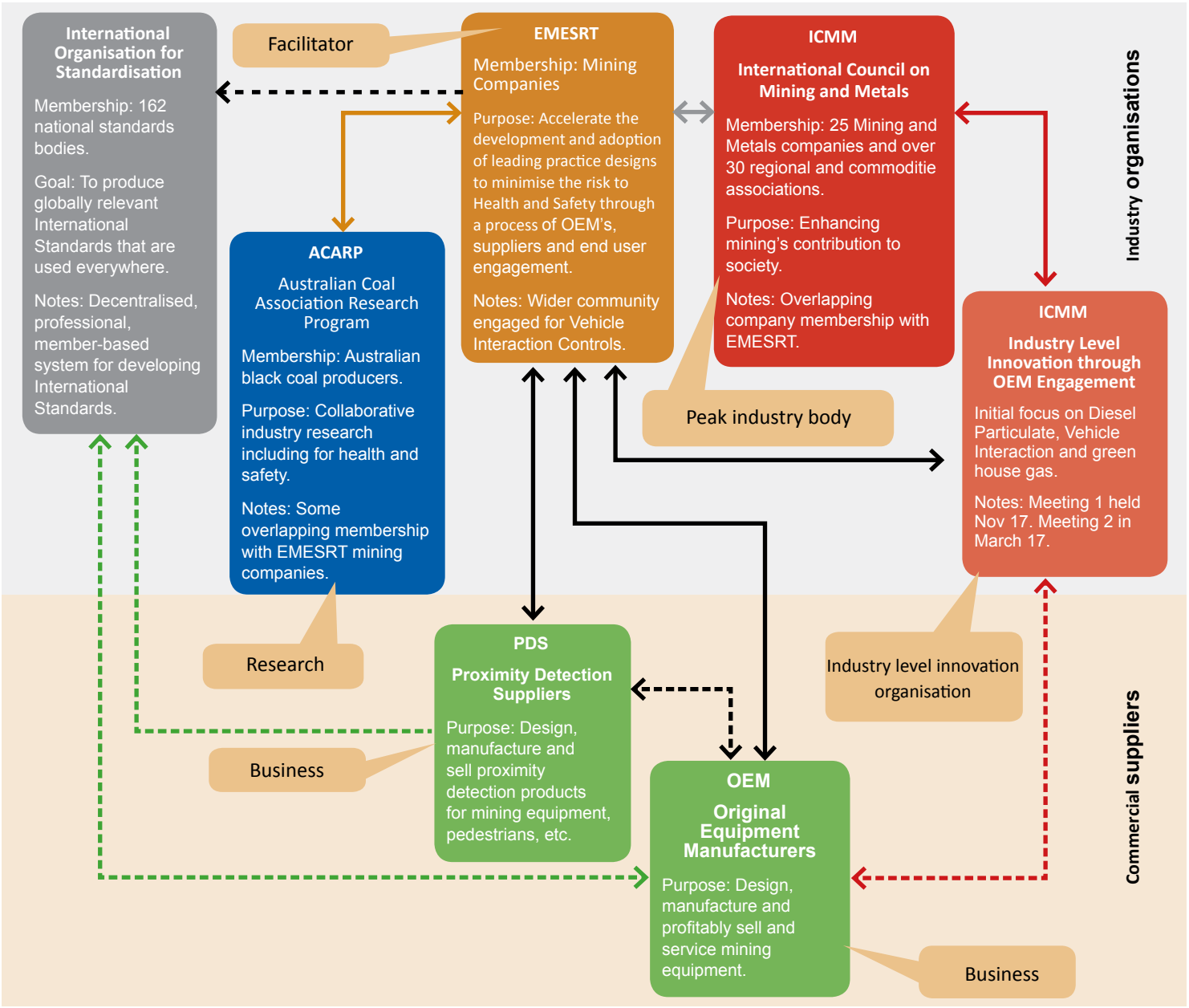



**Figure 1:** Current EMESRT industry level work for the Vehicle Interaction Control Improvement project.

# OUR MEMBER REACH

Our member company representatives provide both operational and strategic direction while contributing to the delivery of projects. From time-to-time, they also promote EMESRT at industry forums outlining our vision, purpose, approaches, successes and project progress. Presentations from credible industry leaders reconfirms the value of our resource material and methods to a range of audiences. Their advocacy and direct contribution to EMESRT, has over time increased industry design capability for mitigating or eliminating the risks faced by earth moving equipment operators and maintainers.

| Member Company | Advisory Group Representatives | Strategic Group Representative |
|---|---|---|
| Alcoa | Raymond Wilson | TBC |
| Anglo American | Matthew Clements | Rene Aguilar* |
| Barrick | Bob Dechant | Craig Ross* |
| Glencore | Tony Egan<br>Wayne Clement | Steven Eichstadt |
| Newcrest Mining | Tony Syme*<br>Lyndsay Potts<br>Graham Eldridge | TBC |
| Peabody | Alan Miskin | TBC |
| Rio Tinto | Mark Geerssen<br>Michiel Phillips<br>Jess Lawler<br>Claire Somerville-Brown<br>Colin Nexhip | Kevin McLeish* |
| BHP[1] | Iain Curran | TBC |

[1]BHP are planning to resume active EMESRT Membership in 2018
* No longer in role

The EMESRT methodology builds communities of interested parties based on projects and then facilitates interactions between participants to deliver project goals and milestones. Participants in our current vehicle interaction control improvement project are listed below.

| Participant Category | Organisation | | |
|---|---|---|---|
| OEM | 1. Atlas Copco<br>2. Caterpillar<br>3. Hitachi | 4. Joy Global<br>5. Komatsu<br>6. Liebherr France | 7. Liebherr USA<br>8. PH Mining<br>9. Sandvik |
| Government, industry associations and researchers | 1. ACARP<br>2. CSIRO | 3. MOSH<br>4. MSHA | 5. Mining3<br>6. NIOSH |
| PDS and other third party equipment, systems and support suppliers | 1. Altech Netstar<br>2. Asirobots<br>3. Becker Mining<br>4. Blue Electronics<br>5. Booyco Engineering<br>6. GE Mining | 7. Guardvant<br>8. Hexagon (SafeMine)<br>9. Matrix<br>10. Minetec<br>11. Modular<br>12. MSHA | 13. Nerospec<br>14. PBE Group<br>15. Schauenburg<br>16. Sedna<br>17. Strata |

# 2017 IN SUMMARY - MILESTONES AND ACTIVITIES

During 2017, we made significant progress in delivering industry-level outcomes. Table 1 summarises the milestones achieved during the year, while Table 2 provides some key statistics.

**Note:** Ongoing EMESRT teleconferences are not included in either table.

**Table 1:** Milestones and activities achieved during 2017.

| JANUARY | FEBRUARY | MARCH |
|---|---|---|
| • EAG planning session held in Newcastle<br>• QRC Field Guide released – includes EMESRT chapter and use of Level 1-9 models | • EAG meeting and workshop preparation<br>• EMESRT holds third face to face workshop with OEM's and PDS suppliers | • EAG User Requirements guide completed<br>• NIOSH joins the EMESRT Vehicle Interaction community |
| **APRIL** | **MAY** | **JUNE** |
| • EAG User Requirements guide distributed for industry review | • Membership fees restructured<br>• EMESRT member resources updated<br>• Vehicle Interaction (VI) / Collision Avoidance teleconference with ICMM Risk Committee<br>• EMESRT briefing note distributed to ICMM representatives of member companies and ICMM Risk Management Working Group for Collision Management | • First draft ICMM VI collaboration working paper completed – with industry-level activity VI landscape map<br>• EAG User Requirements guide – user feedback summary prepared/ reviewed |
| **JULY** | **AUGUST** | **SEPTEMBER** |
| • EAG guide – notification EMESRT withdraws support for any draft versions of User Requirements guide<br>• EAG workshop held – summary of stakeholder project roles prepared based on VI landscape work | • VI collaboration working paper for ICMM Risk Management Working Group prepared | • VI collaboration working paper approved and distributed to ICMM – summarising work to date and proposing a collaborative project |
| **OCTOBER** | **NOVEMBER** | **DECEMBER** |
| • EAG strategy and medium to long range planning workshop held over two days<br>• Workshop outcomes summary distributed to all EAG members – to confirm outcomes and next steps<br>• EMESRT VI Network briefing note prepared which provided EMESRT perspective on unexpected ICMM Innovation Summit | • EAG contribute to ICMM Technology Summit white paper<br>• EMESRT participate in and contribute to ICMM Technology Summit | • EAG workshop held to confirm VI functional requirements<br>• P2017 summary report prepared<br>• Detailed 2-year rolling plan prepared |

# ENGAGEMENT ACTIVITIES

The EMESRT secretariat maintains a master stakeholder contact list organised by category ensuring that communicating to a target audience is efficient and effective.

We also use the LinkedIn platform and industry forums to engage more widely.

**Table 2:** Engagement activities during 2017.

| Activity | Details | Notes |
|---|---|---|
| Presentations | • SAIMM Proximity Detection and Collision Avoidance Systems Colloquium - April<br>• Queensland Mining Inspectorate - March<br>• Mining3 industry forum - October<br>• Hexagon industry forum - November | The presentations were delivered by invitation from mining entities |
| Advisory Group | • Monthly teleconferences<br>• Face to face strategic planning workshop in Brisbane and Perth<br>• Regular emails and telephone calls | The Advisory Group communicates on a regular basis via teleconferences and email Two face to face meetings are held annually |
| Working Group | • Face to face meeting in February<br>• Teleconference<br>• Regular email communication and sharing of information | 126 representatives from 41 entities worldwide are members of the working group |
| Webinars | • Monthly worldwide webinars held on the first Thursday of each month<br>• Two sessions per day to accommodate different timezones<br>• Email communication as required | The two sessions are designed to accommodate the time zones and to reach as many EMESRT global community members as possible |
| LinkedIn | • Monthly worldwide webinar agenda posts<br>• Updates on project activities<br>• Newsworthy posts<br>• Updates on ISO protocol progress | Posts are added to LinkedIn regularly in particular during events and the agenda for monthly webinar sessions |

# VEHICLE INTERACTION PROJECT

## PROJECT OVERVIEW

EMESRT research (global data set 2004-2009) confirms that operating vehicles (mobile equipment) and driving present the highest mining industry fatality risk, at 30 to 40 percent of all incident reports with just over half the fatalities being pedestrians.

In late 2013, and based on the rapid development of *collision avoidance systems*, EMESRT leveraged the existing Design Principle DP-5, 'Machine Operation and Control, and proven methodology to:

- Clearly define the problem
- Understand and confirm the scenarios
- Build a set of performance requirements to assist with the evaluation of PDS technologies on the market

## COMMUNITY ESTABLISHMENT AND ENGAGEMENT

The EMESRT facilitative approach has created an industry level project community made up of:

- Mining companies
- OEM's
- Third party PDS providers and other stakeholders
- Regulators
- Industry associations, e.g. MOSH from South Africa
- Technical and human factor researchers, e.g. ACARP, CSIRO, Mining3, NIOSH, universities, industry-sponsored organisations
- Expert technical contractors (as required)

The current community for the vehicle interaction control improvement project includes 126 active contacts, some holding both ISO committee and OEM roles, representing 41 organisations made up of:

- Nine mining houses
- Nine major global OEM's
- Five government, industry associations and researchers (ACARP, CSIRO and Mining3 in Australia, MOSH in South Africa and NIOSH and MSHS in the USA)
- Seventeen PDS and other third-party equipment, systems and support suppliers

Central to this complex work was the adoption of a 9-level hierarchical model, shown in Figure 2. This was used to confirm and identify focus areas for the work.

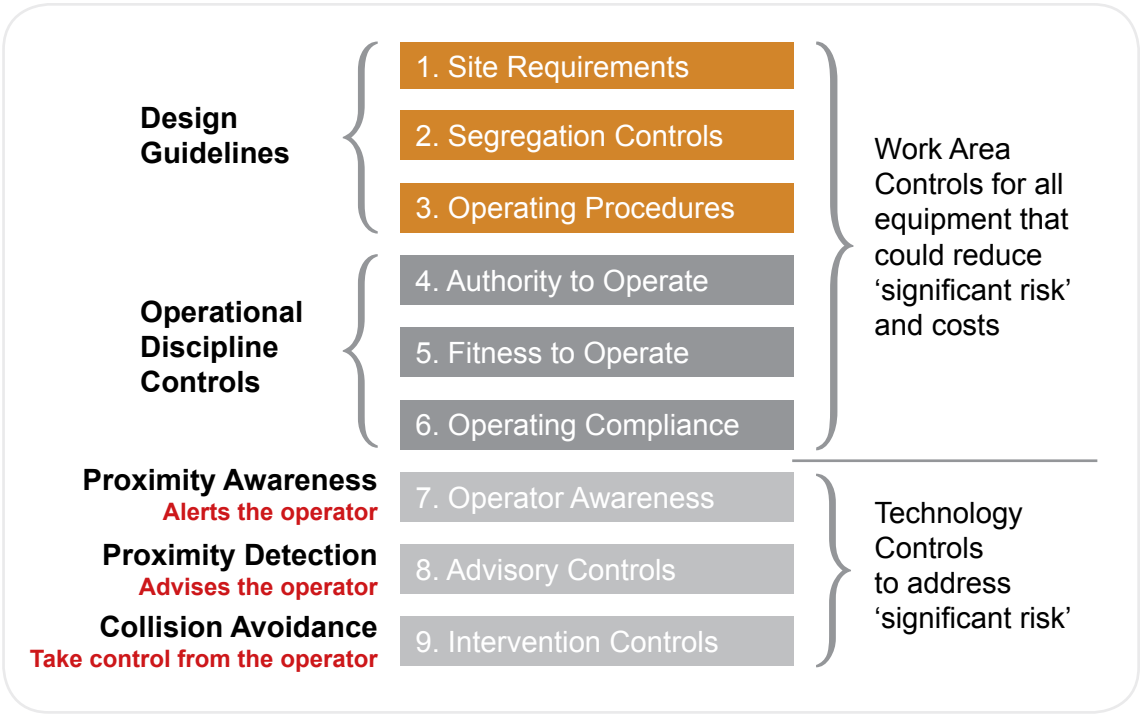



**Figure 2:** The 9-level hierarchical model.

## ISO 21815: EARTH MOVING MACHINERY - COLLISION AWARENESS AND AVOIDANCE

Since 2015, a key EMESRT vehicle interaction initiative has been facilitating the development of interoperability protocol between third-party PDS providers and equipment supplied by OEM's.

The intent of this work is to establish a platform for ongoing collaboration in vehicle interaction design improvement between users, OEM's and PDS vendors. A common interface protocol is required for the implementation of PDS controls in mixed equipment fleets.

The work undertaken on this ISO journey is as follows:

- September 2015 – ISO TC 127 registered as new area of work
- First OEM- PDS workshop to initiate development of interoperability protocol (2015)
- Second OEM-PDS workshop (2015)
- Third OEM-PDS workshop - agreed alignment on the details of the industry protocol (March 2016)
- April 2016 – Industry Protocol Proposed submitted to support new standard collision avoidance systems
- July 2016 – Project approved by ISO and industry working group formed
- December 2016 – Update of ISO 15143 data dictionary
- February 2017 – EMESRT working group face-to-face meeting with 38 industry attendees to prepare feedback on ISO 21815 Parts 1–3
- March 2017 – Communication Interface Protocol Working Draft J1939 delivered to ISO technical committee
- July 2017 – EMESRT hosts ISO 21815 Collision Awareness and Avoidance JWG 28 meeting in Brisbane
- June-August 2017 draft work with ISO 21815 Committee. ISO 21815 Part 2 – Interface protocol issued for final comments from committee and related parties including the OEM- PDS working group via EMESRT

## SURFACE USER REQUIREMENTS GUIDE

Over the past three years, EMESRT has been coordinating the development of an industry how-to resource, designed to set parameters for supplying, installing, integrating and commissioning new technology collision management solutions. This resource was initially developed for in-house use by a member company and then made available as a working document for broader mining industry with further development coordinated and sponsored by EMESRT.

Several drafts of the Guide to Preparation of User Requirements for Collision Management Systems Open-cut / Surface Mining Operations were then extensively reviewed by the EAG and wider EMESRT community. Their consistent feedback confirmed that the *Guide* was overly complex and the methodology it advised was difficult to apply.

As a consequence, the EMESRT Advisory Group withdrew support for the draft guide on 26 July 2017. While the document's intent and content were considered sound, the decision acknowledged that the current structure and style did not meet EMESRT philosophies and standards for publication and that there was no simple solution for these issues.

A request was distributed to the vehicle interaction control working group asking that references to the *Guide* as an industry-agreed standard or mention of its scheduled release were to be corrected. The draft guide is no longer available from EMESRT. It is expected that in 2018 a more suitable resource will be prepared as part of the Vehicle Interaction Control Improvement Project.

# INDUSTRY LEVEL COLLABORATION

In late 2016, senior executives from companies with common membership of the ICMM and EMESRT recognised that both organisations had prioritised industry-level projects to improve collision management and vehicle interaction controls. In early 2017, both groups agreed to explore opportunities for industry-level collaboration and coordination.

Bringing together ICMM's peak industry association status and organisational reach, with EMESRT's global network and design acceleration experience, presents an invaluable opportunity to influence, coordinate and guide vehicle interaction control improvement work at a mining industry level.

The collaboration project intent is to redefine what is both possible and required to deliver a step change improvement in the design, operate and react controls for vehicle interaction.

The proposed work is underpinned by these three key concepts:

1. New control thinking from the ICMM, Health and Safety Critical Control Management – Good Practice Guide published in April 2015 – specifically the disciplined application of Step 3 – Identify Controls
2. An innovation methodology from EMESRT that seeks to first clearly define the problem and then to confirm understanding based on operational scenarios
3. Innovation thinking that differentiates between operational innovations to improve the performance of existing controls (strongly related to ICMM new control thinking and necessarily driven by the industry) and technology innovations that introduce new controls

EMESRT's position is that there are only two options for improving multi-level, interconnected and operationally dynamic control systems such as vehicle interactions in mining, and these are:

1. Improving existing approaches through review, redesign and better application
2. Introducing new controls that address existing weaknesses, either through control replacement or compensation

This proposal for collaboration advocates a 'not only but also' approach using both improvement options, while also developing a comprehensive and practical understanding of control interdependence. It also confirms this significant collaboration opportunity, considering the aligned missions, experience, membership and strengths of the two industry contributors.

# REAL-WORLD BUSINESS UNDERSTANDING

The establishment of EMESRT in 2006 as a formal global mining initiative was driven by the need to fill the design gap between customer and equipment designer expectations, to deliver multiple value-adding outcomes including economic benefits.

At the time, mining companies were routinely installing significant after-market modifications, at considerable cost and time, to meet their workplace health and safety obligations.

The real-world business drivers for EMESRT recognise that when OEM's understand the operational and maintenance risks from the customer perspective, and make design changes at the factory level, then all parties benefit.

EMESRT supports this outcome by appropriately aligning equipment end users and ongoing engagement with equipment providers. This includes providing practical industry-tailored tools based on well-established risk, design and human-factor approaches.

## OUR REAL-WORLD ENGAGEMENT APPROACH

Our established engagement approach, shown in Figure 3, considers business drivers and interconnections from multiple perspectives.

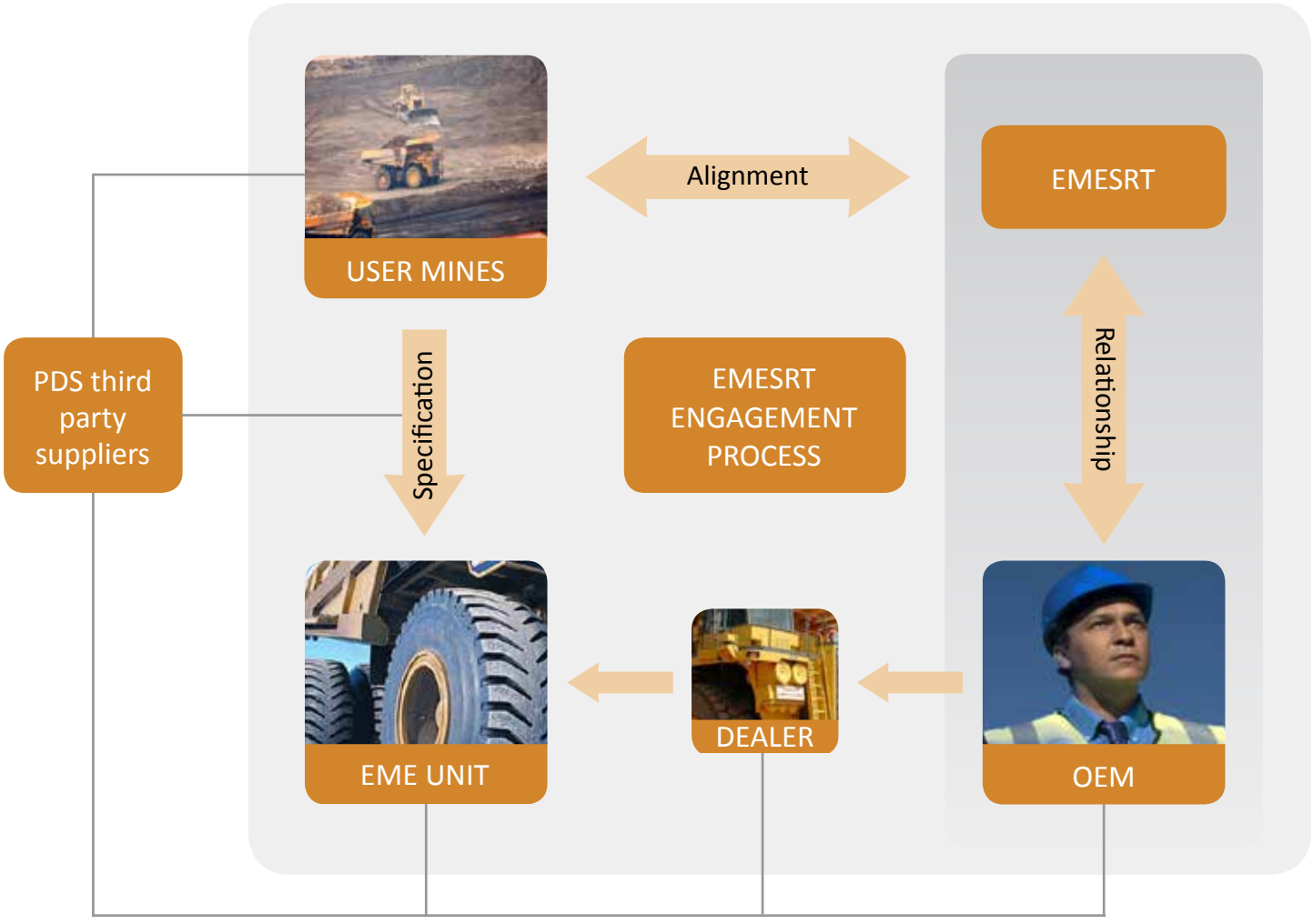



**Figure 3:** EMESRT engagement model.

The real-world value add from EMESRT is in closing the design gap during the purchase of mining equipment. This is achieved through relationships with OEM's and third-party suppliers where EMESRT can influence supplier product design and with appropriate customer alignment through its member companies.

This indirect, non-commercial approach, helps both sides efficiently manage health and safety specifications when selling and purchasing new mining equipment.

In addition, EMESRT's Advisory Group and Strategic Group members are typically experienced company specialists responsible for purchasing fleets of mining equipment for unambiguous commercial outcomes. Some have also worked for OEM's in the past.

Working at an EMESRT level, members are able to influence both company alignment and design direction for earth moving equipment suppliers. Their real-world business understanding and long-term industry relationships provide a level of influence unmatched in the mining industry.

# MARKET DRIVEN

EMESRT works at an industry level to accelerate the development and adoption of design improvements that minimise health and safety risks when operating and maintaining earth moving equipment.

While each member company has its own moral, social, legal and economic drivers to improve health and safety performance, working collectively through EMESRT delivers these benefits:

- Leverage and influence at industry scale
- Input into a common-voice engagement process with OEM and other suppliers based on a proven approach
- Access to resources, experiences and expertise, e.g.. international research and EMESRT tools
- Avoid duplication of work on common issues
- Access to an industry level 'corporate memory'
- Visible company leadership at an industry level
- A neutral way for companies to engage with regulators and standards setters
- Appropriately designed and safer mining equipment

The EMESRT Engagement Model (Figure 3 on page 11) also defines the market and is further reflected in this EMESRT statement from 2006:
*Marketing controls the R&D spend. Therefore, just working through engineers does not achieve optimal change in OEM designs*.

Collectively, member companies represent a significant percentage of the mining earth moving equipment market and, while this profile is clearly recognised by OEM and third-party suppliers, the EMESRT approach is not about using commercial leverage to deliver what the end-user thinks that they need.

Instead it identifies the potential market through a common industry voice, which defines improvement opportunities that allow OEM's and other providers to then develop their own business case for further research, development, manufacturing and marketing.

The success of this market-confirming approach is illustrated by the rapid uptake of working at height and equipment access design changes between 2008 and 2012. This is practically illustrated with a case study on page 17.

# EMESRT - A BRIEF HISTORY

Since early this century, mining companies have jointly discussed the contribution of earth moving equipment design to unwanted events such as incidents, damage and production delays. For six mining companies, these discussions evolved into a formal global initiative in 2006 – the Earth Moving Equipment Safety Round Table (EMESRT).

The initiative was driven by the desire to fill the knowledge gap between customers and equipment designers, focusing on new designs where the opportunity for major change was not only possible, but made economic sense. Figure 4 opposite shows how EMESRT evolved and the work achieved since its inception.

The first step was to develop and implement a strategy for mining customers to engage with OEM's. This initially involved meeting with haul truck OEM's to discuss perceived problems (design philosophies), understand each other's perspectives and review related risk management approaches.

Once this approach was confirmed as adding value then the design challenges were expanded from surface haul trucks to all large mining equipment used in surface mining, underground coal and metal mining, along with exploration drilling.

It was time to progress from discussion to demonstrating change. In 2008, this saw the development of OMAT (Operability Maintainability Assessment Technique) that promoted the use of the EMESRT Design Philosophies by engaging users in a structured task based methodology. Then in 2011, EMESRT took the next step in the OEM engagement process, connecting the issues and methods discussed with a process of evaluating OEM equipment design as part of the mining company procurement process.

Today, EMESRT provides OEM's with an EMESRT Design Evaluation for Earth Moving Equipment (EME) Procurement process known as EDEEP. This process is described in more detail later in this report. Essentially, the process enables OEM's to demonstrate that they are designing beyond standards and applying task-based design reviews, as well as clearly linking design features to priority issues.

Since 2006, EMESRT has defined and applied an industry engagement strategy which targets leading mining equipment OEM's, to improve design operability and maintainability. EMESRT has developed a known brand that is recognised across the global mining industry.

Today, EMESRT is recognised for its unique process in initiating and influencing change in designs through engagement with OEM's, and has a global network of mining companies and interested individuals that share the 'one industry, one voice' common goal – a mining industry free of fatalities, injuries and occupational illnesses associated with operating and maintaining earth moving equipment.

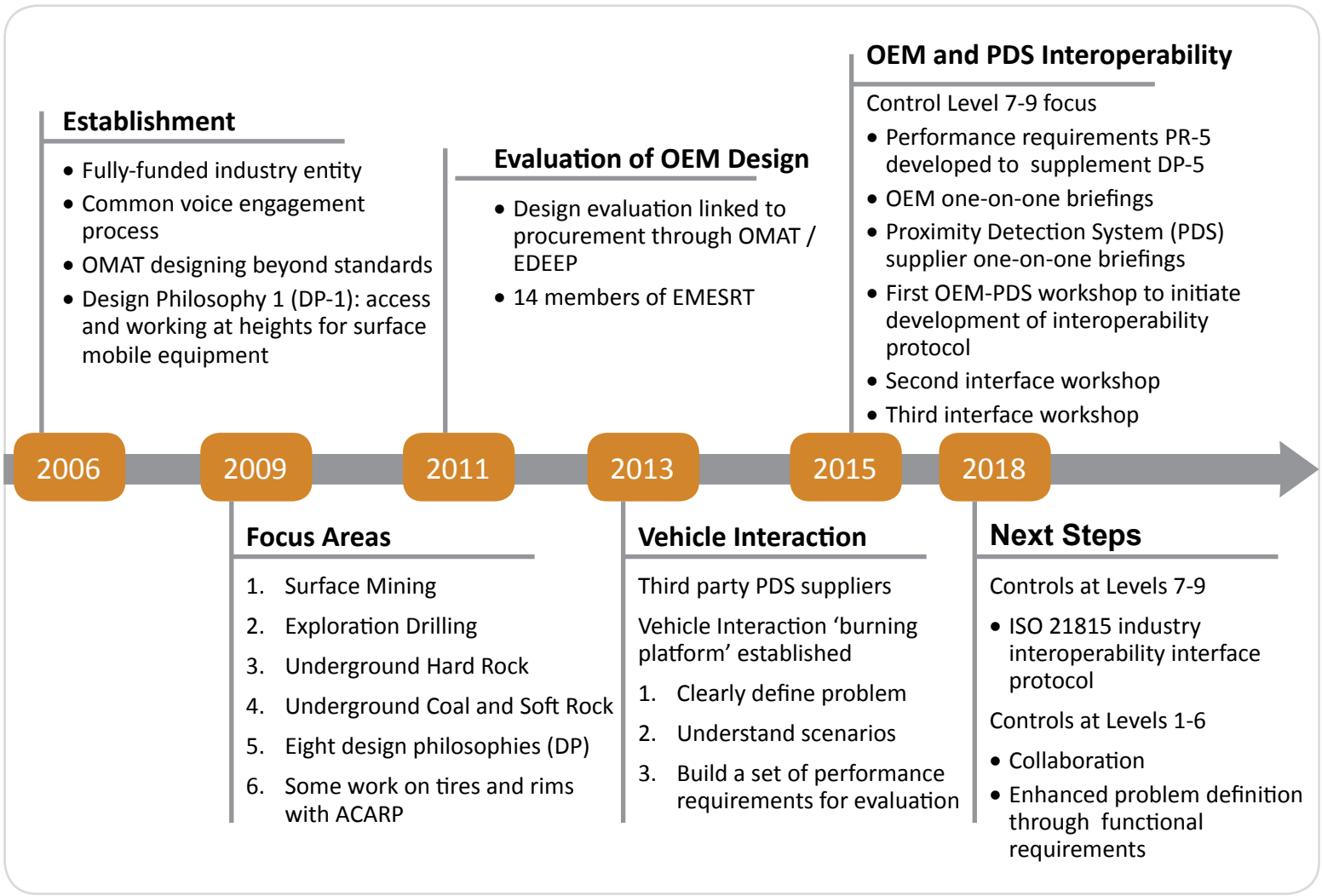



**Figure 4:** EMESRT from inception and into the future.

# DESIGN PHILOSOPHIES

The EMESRT–OEM engagement process is organised around eight Design Philosophies (DP). Each presents an aligned viewpoint on objectives, general design outcomes and the potential unwanted events in a particular hazard category.

Design Philosophy content is developed with the aim of providing information to assist OEM's in designing equipment to reduce the risks of potential unwanted events, including foreseeable human error.

The eight DP categories are:

1. Access and working at heights
2. Tires and rims
3. Exposure to harmful energies
4. Fire
5. Machine operation and control
6. Health impacting factors
7. Manual tasks
8. Confined spaces and restricted work areas

The EMESRT contribution to improve industry vehicle interaction controls arises from DP-5 Machine Operation and Control.

The DP's motivate the designer to consider machine design from the perspective of the end user, then to proactively develop new solutions and innovative ways to reduce the risks of maintaining and operating equipment to as low as reasonably possible (ALARP). These are the building blocks of EMESRT's Operability and Maintainability Analysis Technique (OMAT) principles.

## WORKING AT HEIGHT AND EQUIPMENT ACCESS CASE STUDY

In 2006, the industry-level current state showed that serious injuries and fatalities from equipment access and working at height incidents were occurring in most mining companies and across all regions.

EMESRT set out to create a new reality, by working with OEM's to incorporate critical customer requirements as a basis for improvements to equipment access and working at height controls at the design and development phase.

This was the first of EMESRT's eight design philosophies (DP-1), and its objectives were to:

- Prevent harm related to access and working at height, where there is a risk of falling at least 1.8 m (six feet) or if serious injury may result
- Reduce slip and trips, sprains and strains, falls from height and failure to egress in emergency events to as low as reasonably practical (ALARP), including consideration in design for foreseeable human error

The intended design outcome should consider and/or include:

- Stairways, walkways, access and work platforms, railings, step/grab handle combinations and boarding facilities, including an alternate path for disembarking in case of emergency
- Ergonomic access systems so 3-point contact can be maintained and sprain/strain risk is minimised
- Access systems and work platforms that are well lit, clear of slip and trip hazards, and located and designed to minimise impact on operator vision
- Openings designed for body size variability, escape apparatus and personal protective equipment (PPE)
- Priority – ground entry to access on operator's side, with isolation and other service points (hydraulic, air) located near this operator access
- Service points, inspection points and ancillary equipment located to eliminate work at height during routine maintenance or repair
- Work platforms provided with suitable controls to eliminate work at height and prevent risk of tools and other objects falling onto people below
- Where impractical to provide equipment-mounted work platforms, appropriate roll up access and work platforms or other means designed for workshops
- Where work at height cannot be eliminated, provide fit-for-purpose anchor points or static lines, appropriate for PPE/rescue systems

**Figure 5:** Case study access improvements to the Caterpillar D11 T dozer based on DP-1.

Moving access to equipment from this...

to this...

# KEY EMESRT PROCESSES

With support from the Minerals Industry Safety and Health Centre (MISHC) at The University of Queensland in Brisbane, EMERST has developed two important processes – Operability and Maintainability Analysis Technique (OMAT) and Design Evaluation for Earth Moving Equipment Procurement (EDEEP).

## OPERABILITY AND MAINTAINABILITY ANALYSIS TECHNIQUE (OMAT)

OMAT is a 'beyond standards' method which focuses on operational and maintenance tasks for any piece of equipment. It is a task-oriented risk assessment developed to help designers identify and understand the human factor issues associated with operating and maintaining equipment, see Figure 6.

Ideally, OMAT should be implemented by OEM's at the concept stage of equipment design, but it can also be used on site to review newly purchased or existing equipment. Ultimately, it aims to eliminate design-related safety issues through strategic hazard identification, risk ranking and control selection.

For designers within OEM's, the process increases the awareness of ergonomic and human factor risk management issues in designing heavy earth moving equipment for mining companies. This awareness enables them to be proactive in incorporating these ideas into their designs.

*The OMAT training manual is available for download at emesrt.org.*

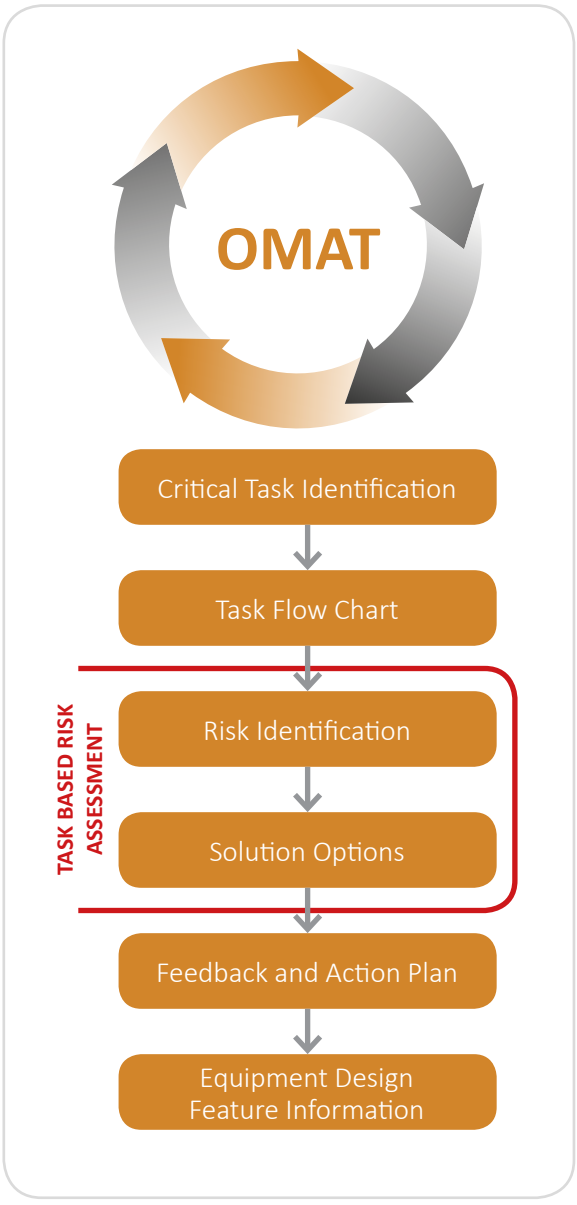



**Figure 6:** The OMAT process.

## DESIGN EVALUATION FOR EARTH MOVING EQUIPMENT PROCUREMENT (EDEEP)

The EDEEP process is a suite of tools that includes the OMAT principles. It was developed to help OEM's demonstrate how they have addressed the problems set out in the DPs. Meanwhile, using the design controls helps industry members thoroughly evaluate OEM equipment at a residual risk within maintenance and operability tasks.

The EDEEP document is made up of key sections directing the user towards a final document to be supplied to the purchaser for evaluation. These sections include:

- Critical Task Identification (CTI) information
- DP reference information
- Task Based Risk Assessment (TBRA) document information
- Design feature information from the TBRA

EDEEP enables mining companies considering purchasing equipment to obtain high quality information about equipment safety features in a standardised form. Completing the EDEEP process or equivalent will give OEM's the information they need to design equipment 'beyond standards'.

The information kit provides background materials, including the EMESRT DPs, and a manual describing OMAT for task-based risk assessment, with a spreadsheet for documenting priority tasks, task-based risk assessments and the resulting Safe Design Information. It also includes a more detailed explanation of the process outlined in this report.

*EDEEP process documents are available for download at emesrt.org.*

# SENIOR LEADER ENDORSEMENT

During and after the 2017 strategy and planning meeting, the effectiveness of the EMESRT approach for engaging with and influencing organisational decision-makers was reviewed.

It was recognised that an extensive positive industry-level profile has been established with senior managers at OEM's and third-party equipment providers. It was also recognised that EMESRT connects at appropriate senior management levels with other stakeholders, such as research organisations, regulators and some industry groups.

This profile was reconfirmed during the ICMM Technology Summit, held in November 2017, where senior manager OEM attendees publicly recognised and endorsed EMESRT successes and our ongoing relevance.

In contrast, EMESRT has a lower profile with senior managers in member organisations, and peak industry groups and associations. This was identified as an area for improvement as wider industry alignment about the problems facing end users confirms and supports the business case for OEM's to invest in design changes.

Actions to address this significant success factor gap are now part of the rolling 2-year EMESRT Work Plan, and include:

- Applying the experience and skills of new and existing EAG members to ensure that EMESRT materials and approaches are suitable for their intended audience
- Preparing a formal stakeholder management plan in early 2018
- Restyling EMESRT update information for adaption and use by member companies
- Updating EMESRT's reporting style and format to work for a broader audience range, such as this report
- Ongoing participation in work at the ICMM industry peak body level, in both project work and in an advisory capacity, such as on governance, process and structure

# GOVERNANCE

## STRUCTURE

EMESRT is an organisation set up to deliver practical outcomes at an industry level, with a work program largely based around coordinating the delivery of specific projects. Advisory group members, who are senior managers in their respective organisations, make contributions based on their availability, experience and expertise.

Meanwhile, secretariat support is provided on a fee for service basis by Mining3, a leading research organisation with global mining industry members, and further expert consultant support is sourced as required. Our operating model is shown in Figure 7 below.

## FUNDING

EMESRT membership is limited to mining companies. Member companies pay an annual membership fee and, based on project load and planning, make more funds available as required.

Many projects involve coordinating and connecting work already in progress by other sources. Examples include ACARP's coal industry research, university research, and other technical R&D by other research organisations.

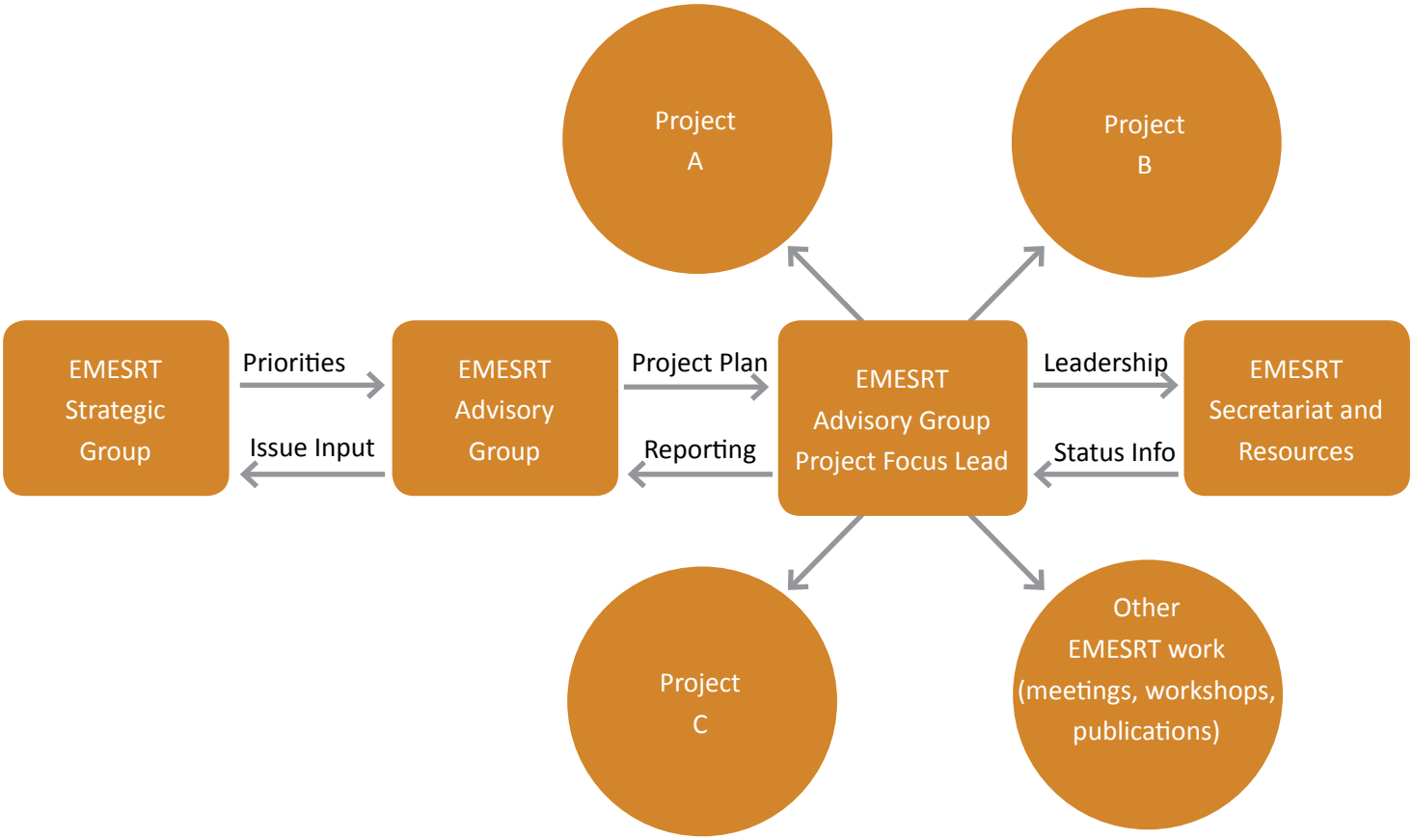



**Figure 7:** EMESRT operating model.

## OEM AND THIRD-PARTY ENGAGEMENT

EMESRT members are well aware of managing anti-trust issues and processes have been in place since OEM engagement work commenced.

In scope, EMESRT will:

- Focus on design of earth moving equipment in surface and underground mines
- Provide aligned design expectations based on risk
- Involve interested companies in the industry
- Share openly with all interested OEM's
- Listen, consider and value OEM contributions
- Provide information on leading practice to OEM's
- Share leading practice to assist users in achieving health, safety and environmental compliance goals

Out of scope, EMESRT will not:

- Discuss commercial issues or anything of an anti-trust nature
- Provide approval for OEM or third-party design
- Share OEM confidential information with other OEM's
- Impose adoption of solutions on member company sites

EMESRT projects and important communications undergo legal reviews to avoid liability and anti-trust issues.

While EMESRT can point to many successes over the past 12 years, our advisory group and strategic group members recognise that our profile within member organisations and non-member mining is relatively low. Further detail on steps being taken to manage this risk is provided in Senior Leader Endorsement on page 19.

## CONTINUITY AND RENEWAL

One of EMESRT's significant strengths is the continuity of its member organisation representatives. The core group has been involved since EMESRT began and have made significant contributions to both organisational development and the delivery of projects.

Beyond this, each brings their professional skills which support a focus of practical delivery. Together, this deep understanding of EMESRT's purpose, design philosophies and success factors ensures rapid industry-level responses are coordinated based on current issues.

The EMESRT work plan details how these experienced member-company representatives have committed to formalising what has proven to be a very effective semiformal process. In addition, an ongoing renewal of company representatives is also being managed, which includes multiple representatives from some member companies.

For EMESRT, an increase in diversity of experience and skills is invaluable, as it assists us in dealing with opportunities identified during 2017 planning, which are captured in this report. This particularly applies to senior management endorsement, further industry level collaboration, and formalising the processes that have delivered success over the last 12 years.

## STRATEGY AND PLANNING

Over two days in early October 2017, the EMESRT Advisory Group (EAG) met to:

- Review project progress with vehicle interaction control work
- Introduce new members to the organisation, explaining benefits of membership and EMESRT history, successes and how it operates
- Plan for the next two years by reviewing relevant industry problems and considering potential EMESRT inputs
- Identify the contribution new and existing members can make in preparing and delivering EMESRT strategy and plans

The output from this two-day facilitated workshop is summarised in Tables 1 and 2 on page 23 and 24, and forms the basis of the current rolling 2-year EMESRT work plan.

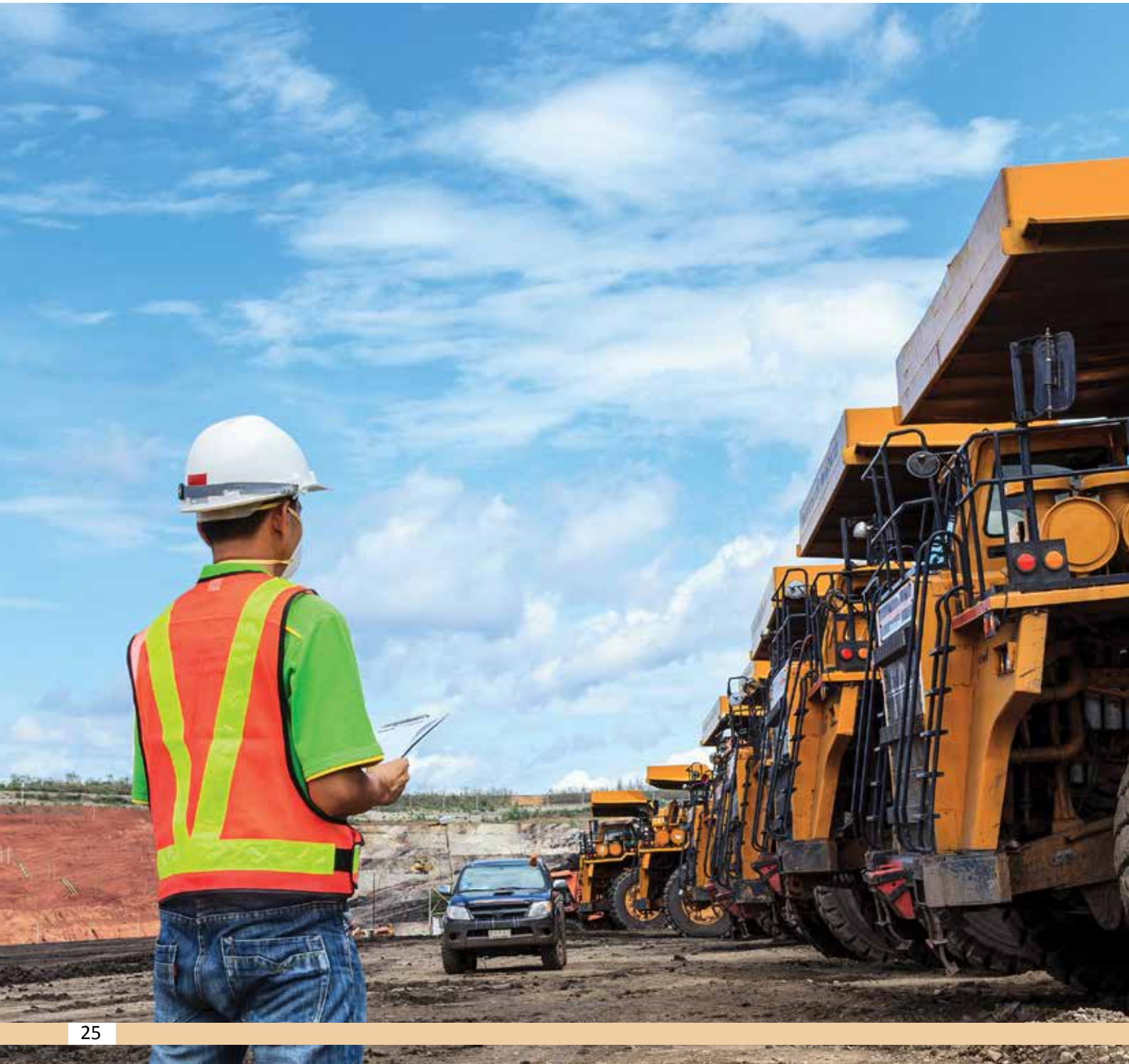
| EMESRT Organisational Objectives - Maintaining and Enhancing Key Processes | | |
|---|---|---|
| **Reference** | **Description** | **Next steps** |
| **Objective 1** | Update existing material, outline EMESRT member company benefits for the short to medium term, as well as making a contribution to industry including long-term strategy covering:<br>• EMESRT history and notable milestones<br>• Monthly industry forum on vehicle interaction control progress<br>• Stakeholder identification and management plans, e.g.. interface with researchers, regulators, standards setting bodies | **Short term:** Refresh and re-issue new and existing member support material by Q1 2018 for review.<br><br>**2-year plan:** Confirm resources required to maintain and enhance EMESRT resources and engagement processes. |
| **Objective 2** | Review and refresh EMESRT Design Philosophy (DP) content and style, including:<br>• Completing a survey/review of DP users and reconfirming audience, e.g.. designers<br>• Where possible, linking to examples where DP is applied<br>• Improving support material where required, e.g. replacing stock photos with illustrations that better summarise design improvement opportunities | **Short term:**<br>• Update specific topic areas discussed during planning workshop, e.g. tires and rims, equipment fires, gender neutral equipment<br>• Include topics not discussed in detail, e.g. functional safety, cab controls to manage exposure to silica<br>• Confirm relevant anchoring DP<br><br>**2-year plan:**<br>• Review and refresh DP content and style<br>• As required, review specific topic summaries and prepare performance requirements, e.g. equipment fires, managing tires and rims, and other topic areas where the existing DP's do not provide enough detail for designers to fully understand the performance requirements |
| **Objective 3** | Confirm evolution of EMESRT approaches – review and refresh EMESRT key methodologies based on extensive work to establish the vehicle interaction control workplan and previous successes, with input from all EAG members covering:<br>• Confirming vehicle interaction case study approach, and establishing position on aligning/integrating it into ICMM critical control management (CCM) framework<br>• Aligning application of tools such as EDEEP and OMAT with new control thinking (ICMM CCM)<br>• Capturing knowledge and experience of long term EAG members<br>• Documenting evolution of EMESRT methodology, e.g.<br>o Using industry level landscape mapping to identify interconnects and opportunities for new projects<br>o Enhancing problem definitions for designers by confirming functional requirements<br>o Identifying and managing stakeholders (Objective 4) | **Short term:** Review ICMM Vehicle Interaction Workplan proposal to identify how EMESRT approach has changed over the last 5 years<br><br>**2-year plan:** Update EMESRT methodology, processes and tools, and illustrate their application through real world case studies. |
| **Objective 4** | Prepare a formal EMESRT stakeholder approach methodology to improve EMESRT profile for member companies and industry associations. | **Short term:**<br>• Working examples provided by members for further EMESRT development<br>• Practically apply this approach for current vehicle interaction control project, such as for ICMM conference presentation in November 2017<br><br>**2-year plan:** Update EMESRT methodology – seek new member advice, and further external support as required. |

| EMESRT Industry-Level Projects 2017 | | |
|---|---|---|
| **Reference** | **Description** | **Next steps** |
| **Project 1** | **Summary:** Vehicle interaction control improvement project.<br><br>*This incorporates all EMESRT work to date, including developing ISO 21815 industry interface protocol and control level models.* | **Short term:** Complete these actions before end of October 2018:<br>• Update potential user guide replacement from ACARP C26028 PDS Validation Testing Framework and communicate next steps intent<br>• Building from landscape diagram project summaries, prepare stakeholder management plan<br>Prepare ICMM conference information for attendees:<br>• Modify short collaboration proposal to include operational innovation support by new and existing technology (level 1-6 controls) and new technology innovations (level 7-9 controls)<br>• Include some details of the EMESRT approach and successes in presentation, e.g. OEM rules of engagement |
| | | **2-year plan:** For vehicle interaction control improvement project, confirm:<br>• Build from acceptance by ICMM of collaboration proposal in March 2018<br>• Complete detailed planning, including resourcing |
| **Project 2 - key step** | **Detail:** VI control - Design Functional Requirements<br><br>As key part of Project 1, enhance industry problem definition understanding for vehicle interaction controls by defining functional requirements. | **Short term:** Source latest developments from member companies based on ICMM Critical Control Methodology<br>• Review and format for distribution and in-company review and feedback by other EMESRT members |
| | | **2-year plan:** Confirm and establish an industry reference standard for vehicle interaction functional requirements that:<br>• Can be used by designers<br>• Will become a key organising methodology for the project |

# ACKNOWLEDGEMENTS

The EAG acknowledges and greatly appreciates the time and effort member company representatives and others put into meetings, webinars and other associated EMESRT activities. We value your generous support and your exceptional experience and expertise.

Thank you also to the OEM's, PDS suppliers and the general mining community for your support of EMESRT since our formation in 2006. You are all part of our success story.



# GLOSSARY

| | |
|---|---|
| ACARP | The Australian Coal Industry's Research Program |
| ALARP | As low as reasonably practical |
| CAS | Collision Avoidance System |
| CCM | Critical Control Management |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| CTI | Critical Task Identification |
| DP | Design Principles |
| EAG | EMESRT Advisory Group |
| EDEEP | EMESRT Design Evaluation for EME Procurement |
| EME | Earth Moving Equipment |
| EMESRT | Earth Moving Equipment Safety Round Table |
| ESG | EMESRT Strategic Group |
| ICMM | International Council on Mining and Metals |
| MISHC | Minerals Industry Safety and Health Centre |
| MOSH | Mining Industry Occupational Safety and Health (MOSH) formed by South African Chamber of Mines and its social partners, government and labour |
| MSHS | Mine Safety and Health Administration (USA) |
| NIOSH | The National Institute for Occupational Safety and Health (USA) |
| OEM | Original Equipment Manufacturer |
| OMAT | Operability and Maintainability Analysis Technique |
| PDS | Proximity Detection Systems |
| QRC | Queensland Resources Council |
| R&D | Research and Development |
| SAE | Society of Automotive Engineers |
| TBRA | Task Based Risk Assessment |
| VI | Vehicle Interaction |

# APPENDIX 1 - EMESRT PERFORMANCE SNAPSHOT

| Success factors | | Benchmarked against the Carbon Trust[1] | EMESRT - The organisation |
|---|---|---|---|
| **1.** | Working at an industry level | Joint industry collaborations focus on sector-wide benefits, identified through rigorous, objective, fact-based analysis and extensive sector-wide engagement. | Strategy and project direction informed by experience of company representatives with internal multi-site responsibilities, and who often represent their organisations in other industry forums. |
| **2.** | Real world business understanding of financial drivers and leverage | Meaningful financial leverage secured for joint industry collaborations to enable greater overall impact and ensure industry commitment. | Member backgrounds include mining company engineering and commercial expertise, such as in purchasing mining equipment fleets. |
| **3.** | Understanding that innovation is market-driven, not pushed by technology | Joint industry collaborations designed to catalyse markets by overcoming commercial barriers rather than championing individual technologies or solutions. | Organisation is based on understanding business drivers (the market) from all perspectives, e.g. market enabling work to prepare an ISO interface standard between mining equipment and PDS technology. |
| **4.** | Governance – structure, funding, risk management, renewal and continuity | Governance structures for joint industry collaborations tailored to specific initiatives but all cover key elements including intellectual property (sharing and protection) and decision making rights. | Established operating model in place with appropriate oversight, and incorporating anti-trust processes. In 2018, committed to documenting and formalising the very effective semi-formal process EMESRT uses. |
| **5.** | Senior management (decision maker) endorsement | Industry partners expected to demonstrate commitment to initiatives through senior management sponsorship. | Member company awareness at different levels, with low profile in many. This extends to non-specialist industry groups and associations. In the current plan, this is identified as an area for improvement. |

| External suppliers - OEM's and PDS suppliers | EMESRT project work - Vehicle Interaction Project[2] |
|---|---|
| EMESRT recognised and acknowledged as delivering sector wide benefits, such as the current diversity of vehicle interaction community. This 'voice of the industry' status is founded on ongoing industry wide engagement since 2006. | Demonstrated by the working group membership and recent project collaboration proposal with the ICMM. |
| The real-world value-add is closing the specification gap when purchasing mining equipment. This indirect, non-commercial approach is achieved by influencing supplier product design and appropriate mine site customer alignment. | The project is based on industry-level coordination work being required before business case can be made to deploy vehicle interaction controls at a mine site level. Includes developing assessments so new technology is fit-for-purpose. |
| The well-accepted EMESRT approach is technology agnostic. It identifies the potential market by defining improvement opportunities, and allows OEM's and other providers to then develop their own business case for further research, development, manufacturing and marketing. | The project has developed a deep understanding of what is necessary to improve multi-level, interconnected and operationally dynamic vehicle interaction control systems:<br>1. Improving existing approaches through review, redesign and better application<br>2. Introducing new technology controls that address existing weaknesses, either through control replacement or enhancement through technology in control support |
| For over 12 years, EMESRT has been recognised as the credible and trusted voice of the industry. This positive position is underpinned by long term relationships between EMESRT member company representatives and OEM's. | Direct project oversight and contributions from advisory group members.<br>Project milestones are being achieved. |
| OEM senior management are aware of and support ongoing engagement with EMESRT. | Supported by all member companies and, in 2017, an ICMM collaboration was for accelerating the design and adoption of vehicle interaction technology EMESRT representatives also attended and presented at the ICMM Technology Summit on EMESRT processes and successes. |

*[1]The Carbon Trust is an independent, mission-driven, expert partner of leading organisations around the world, helping them contribute to and benefit from a more sustainable future (find out more: www.carbontrust.com)*

*[2]EMESRT's Vehicle Interaction Project commenced in 2013 and is ongoing*

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