2019 ANNUAL REPORT

WORKING WITH INDUSTRY SINCE 2006

EMESRT

Earth Moving Equipment Safety Round Table

ABOUT EMESRT

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 SUCCESS FACTORS

In 2018, based on benchmarking and a multi-year performance review, we confirmed and formalised these five success factors for EMESRT:

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

This report is structured using these success factors and provide a status update of our performance against them in Appendix 1.

OUR MEMBERS

EMESRT member companies for 2019 were:

Alcoa

AngloAmerican

BHP

GLENCORE

NEWCREST MINING LIMITED

Peabody

RioTinto

Teck

ACKNOWLEDGEMENT

The EMESRT Advisory Group acknowledges and greatly appreciates the individual contributions of member company representatives and others from the broader EMESRT community of: Mine Operators, Original Equipment Manufacturers (OEM), third party equipment suppliers, Researchers, Industry Groups and others.

Since 2006, their contributions at meetings, workshops, webinars and other activities has directly supported the delivery of the EMESRT vision and they are part of the EMESRT success story.

INTRODUCTION TO OUR 2019 REPORT

The Earth Moving Equipment Safety Round Table (EMESRT) is a global 'safety by design' mining company initiative established to fill the functional performance expectations gap between mining users and equipment designers.

EMESRT have been operating since 2006 and are now a global mining industry brand that engages, influences and facilitates health and safety improvements through communities of mining equipment users, OEM's, researchers and third-party suppliers. In doing this work, the first step is always to develop a deep understanding of issues and problems, before considering a path to better defining the functional performance requirements for designers.

EMESRT exists to reduce and eliminate injuries and fatalities in the mining industry, and this is done by:

- Assisting Original Equipment Manufacturer (OEM) designers and other industry suppliers to develop a deep understanding of customer issues to improve the design of their products
- Facilitating and leading industry projects to address common operational and maintenance issues, e.g. preventing or mitigating mobile equipment fires
- Developing and sharing processes that support safe, healthy, productive and practical outcomes at operating sites

This report provides an update on EMESRT's work in 2019, it introduces two focus projects Management of Mobile Equipment Fires and Tyre and Rim Management and updates progress with Vehicle Interaction Control Improvement and Human Factors Design for Diversity. It also provides information on how EMESRT works, its key processes, activities and achievements.

The intended audience 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, e.g. the ICMM ICSV working groups
- Non-EMESRT member mining companies and contract mining organisations
- Researchers
- All other interested parties

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

All of our reports from 2017 are available on the EMESRT website - emesrt.org.

ACRONYMS

ACARP	The Australian Coal Industry's Research Program
ALARP	As Low As Reasonably Practical
AS	Australian Standards
BI	Business Inputs
CAS	Collision Avoidance System
CCM	Critical Control Management
CEO	Chief Executive Officer
CFM	Credible Failure Modes
CFw	Control Framework
CTI	Critical Task Identification
DP	Design Philosophies
EAG	EMESRT Advisory Group
EDEEP	EMESRT Design Evaluation for EME Procurement
EME	Earth Moving Equipment
EMESRT	Earth Moving Equipment Safety Round Table
HFDD	Human Factors Design for Diversity
ICMM	International Council on Mining and Metals
ICSV	Innovation for Cleaner Safer Vehicles
ISO	International Standards Organisation
OEM	Original Equipment Manufacturer
OMAT	Operability and Maintainability Analysis Technique
PDS	Proximity Detection Systems
PR	Performance Requirement
R&D	Research and Development
ROS	Required Operating States
TBRA	Task Based Risk Assessment
UQ	University of Queensland
VI	Vehicle Interaction
VIS	Vehicle Interaction Systems

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CONTENTS

HIGHLIGHTS FOR 2019

CONSISTENT AND EFFECTIVE INDUSTRY PROJECT SUPPORT

In 2019, EMESRT established consistent processes for the effective management of industry projects including monthly update meetings, common project management processes and online resources to keep the diverse and geographically spread contributors connected and informed. These processes are now being used for all EMESRT led industry projects.

EMESRT CONTROL FRAMEWORK (CFw) CONTINUED DEVELOPMENT AND METHOD SUPPORT

EMESRT is now utilising CFw in all industry projects in well attended verification workshops. The CFw approach captures and organises real-world operational practice and experience. The CFw is presented in ways that can be understood and applied by personnel at all levels. Further detail of this developing EMESRT methodology is available in the body of this report.

MOBILE EQUIPMENT FIRE MANAGEMENT PROJECT COMMENCED

Based on EMESRT Design Philosophy 4 (DP-4) Equipment Fires, 17 experienced and well qualified participants representing seven member and non-member mining companies, fire suppression equipment experts and the regulator participated in two Control Framework Validation workshops held in April in Perth and August in Brisbane Australia. The outputs from their work are the basis of a new Industry Project making good progress against goals that will continue through 2020.

TYRES AND RIMS MANAGEMENT PROJECT COMMENCED

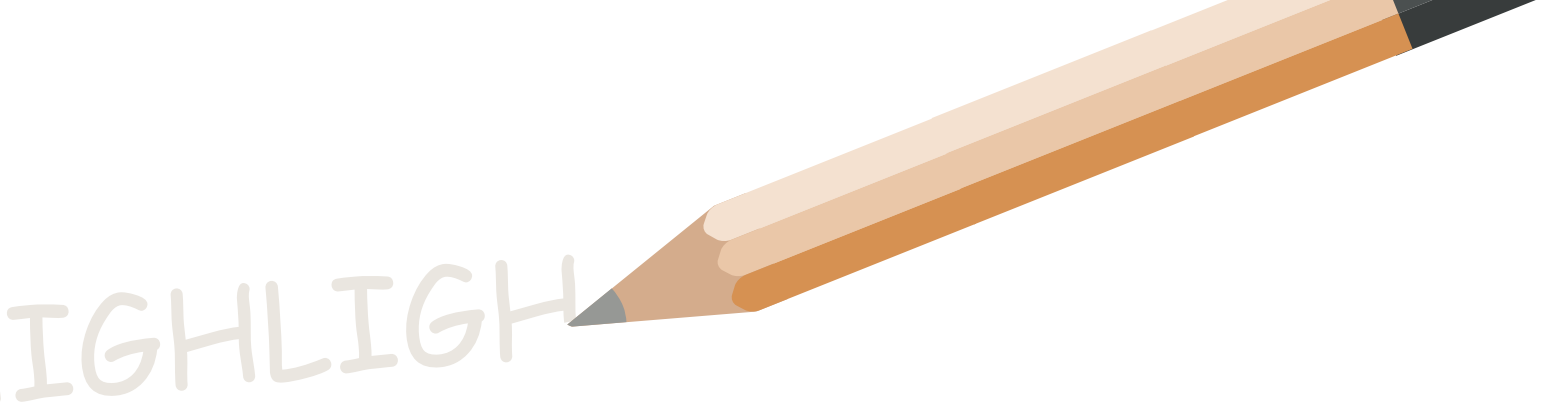
Based on Design Philosophy 2 (DP-2) focusing on Tyres and Rims, 23 experienced mining industry personnel representing 14 organisations, including a regulator representative, participated in two Control Framework Validation workshops held in May and July in Brisbane Australia. The outputs from the workshops are the basis of a focused industry project making good progress against goals that will continue through 2020.

VEHICLE INTERACTION SYSTEM (VIS) CONTROL IMPROVEMENT PROJECT PROGRESS

Since 2013, EMESRT has facilitated an industry-level vehicle interaction systems project with the goal of reducing the unwanted vehicle interaction in mining. While the initial project focus was accelerating the development of awareness, advisory and intervention technologies, this work now includes capturing innovations in the underpinning controls in mine design and mine operations.

ICMM INNOVATION FOR CLEANER SAFER VEHICLES (ICSV) VIS COLLABORATION

Throughout 2019, EMESRT continued to support the ICMM Innovation for Cleaner Safer Vehicles (ICSV) programme, by attending multiple workshops, and providing financial support to develop their Knowledge Hubs.



PUBLISHED VERSION 2 OF PERFORMANCE REQUIREMENT 5A

In consultation with industry, EMESRT reviewed, updated and published version 2 of vehicle interaction Performance Requirement 5A. This important document has guided the ACARP research project to develop a Proximity Detection System (PDS) Testing Methodology. PR-5A provides a focused user definition of levels 7, 8 and 9 of the EMESRT nine level vehicle interaction control model.

HOSTED ISO COMMITTEE IN BRISBANE

EMESRT Hosted the Technical Committee TC 127 (Earth-moving machinery), Subcommittee SC 2 (Safety, ergonomics and general requirements), Working Group 22 and 28 (Collision awareness and avoidance) meetings in Brisbane on 14-18 October 2019.

ISO 21815 COLLISION AWARENESS AND AVOIDANCE PARTS 1, 2 AND 3 PROGRESS

Through 2019, the vehicle interaction working group closely monitored the progress of ISO 21815 Parts 1, 2 and 3 development / approval. Towards the end of 2019, Part 1 was voted on, Part 2 was voted on as a draft standard and Part 3 is still underway. We expect that Part 2 (Interface protocol element) of this important standard will be approved for gazetting in Q1 2020. This will allow designers to commit to including these requirements into their products with confidence.

HUMAN FACTORS DESIGN FOR DIVERSITY PROBLEM DEFINITION AND PROJECT SCOPE DEVELOPMENT CONTINUED

In May 2018, EMESRT coordinated a Human Factors Design for Diversity workshop. Workshop participants included a range of industry personnel including experienced maintainers and operators of both genders. The workshop was facilitated by a mining human factors expert, Professor Robin Burgess-Limerick. One of the key workshop outputs was to better define the activities creating the most exposure and this became the basis of ACARP (Australian Coal Association Research Projects) funded project work that continued throughout 2019.

EMESRT WEBSITE UPGRADE INCLUDING THE DEVELOPMENT OF KNOWLEDGE HUBS FOR CURRENT PROJECTS

The EMESRT website was substantially updated in 2019 to make it more accessible and user-friendly and will be launched in Q1 2020. It will include Knowledge Hubs for industry projects that allow access by intuitive navigation aids to find up-to-date and relevant information and other resources.

MEMBERSHIP

In Q4 of 2019, we welcomed new member Teck Resources and returning member BHP. Their insights and experience are already positively contributing to our industry round table discussions and projects.

ADVISORY GROUP MESSAGE

In 2017, the EMESRT Advisory Group (EAG) reintroduced the annual discipline of reporting on progress towards our goals and reviewing our strategies, plans and purpose. Three reports later, our progress headlines for 2019 are: EMESRT is now leading four industry projects, each with a compelling case for improvement and innovation based on member company and industry experience. These projects represent our external face and are summarised in this report with further information available on our website.

EMESRT exists to bridge the functional design gap between Original Equipment Manufacturers, designers and mining equipment users. Each EAG member is committed to this purpose and contributes while holding senior positions within their respective organisations. The EAG role is to confirm strategy, prepare plans and then support individuals leading relevant projects. This clear purpose combined with a volunteer structure, demands operating processes that are both effective and efficient.

In 2018, we committed to further formalise and standardise these operating processes for three reasons: to sustain the successful operating principles, to grow our capacity and to sustain EMESRT beyond the experience and availability of its current company representatives.

A comprehensive review of our multi-year vehicle interaction project confirmed that the successful facilitation of complex industry projects has these process steps:

- Set up and manage as a project
- Have clear objectives and establish the project from a 'whole of system' perspective
- Manage stakeholders through establishing and regularly engaging with a wide network of contributors over the project life
- Develop a deep understanding of the details of current operational practice
- Identify aspects of current operational practice that can be enhanced by innovation
- Identify the aspects of current operational practice that can be replaced by innovation
- Confirm project leverage points - the work that EMESRT must facilitate and deliver for project success
- Identify areas where EMESRT can engage with other stakeholders and influence the delivery of outcomes that support project goals
- Remain flexible, while having clear milestones and an endpoint

Based on this review, we have developed the EMESRT Control Framework Approach (CFw) as a core operating process. First described in our 2018 report, building a CFw is highly iterative and begins with confirming the required operating states necessary for delivering a business purpose, it then develops a precise understanding of how these safe and productive operating states can be compromised (credible failure modes) while cataloguing the business inputs that prevent or mitigate compromise. As necessary, all CFw component descriptions, content and links can be updated to capture new information and insights.

Notably, this approach provides both a 'whole of system' overview and detailed information about the dynamic interconnects between personnel, equipment, the work environment, workgroups carrying out different tasks and overall coordination. The CFw also promotes the systematic identification of improvement opportunities.

Our approach is simple, yet effective: we define the problem, confirm the landscape and end goals, identify stakeholders, direct resources to leverage points, link communities and then together we influence the delivery of industry level improvements.

EMESRT Advisory Group

In 2019, both EMESRT focus projects: Tyre and Rim Management and Mobile Equipment Fire Management applied this approach. For each, a draft CFw was prepared and then multi-day workshops were held with qualified and experienced participants from multiple organisations. At the initial two workshops held for each project, they worked in small teams to review, update and verify CFw content and logic and capture specific opportunities for improvement and innovation.

For both projects, opportunities were confirmed in these three areas to:

1. Accelerate good practice by defining and sharing details of the business inputs that deliver consistent safe and productive outcomes now
2. Innovate iteratively through identifying where technology can improve existing business inputs
3. Promote step change innovation where new design or technology inputs can replace existing business inputs

In 2020, the CFw workshop outputs will be used to scope project steams and confirm working groups across the three areas listed above. As each project working group is established, it will be supported by common EMESRT project management facilitation principles described above.

Beyond this work to develop and sustain EMESRT operating processes, each year the EAG formally reviews the value that the organisation has delivered for members and the broader mining industry. This review considers both outcomes delivered and influencing effectiveness. During 2019, EMESRT has maintained its profile with OEM's and other industry suppliers while productively engaging and increasing influence with; researchers from around the world, standards setting bodies, broader industry groups, multiple mining operators and member companies.

In 2019, the EAG's commitment to improve how it supports and adds value for stakeholders will deliver a website update and Knowledge Hubs for each industry project. These are scheduled for launch in early 2020 and will provide access to relevant tools, resources and other information for all stakeholders with a focus on supporting people working at operating sites.

This report confirms the 2019 progress and provides key outputs from the annual review of EMESRT strategy, plans and purpose. The EAG is pleased to report that it has been a productive year and that EMESRT is well set up to continue to accelerate the development and adoption of both leading practice designs and operational practice.

The EAG acknowledges the significant financial input from the respective member companies and their ongoing support for their representative's contributions. On their behalf, we are committed to sustaining and improving the value that EMESRT delivers to our industry.

EMESRT Advisory Group
March 2020

1. EMESRT SUCCESS FACTORS: WORKING WITH AN INDUSTRY LEVEL FOCUS

The backstory

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. The initiative was driven by the desire to fill the functional performance knowledge gap between mining equipment users and equipment designers, focusing on new designs where the opportunity for major change was not only possible, but made economic sense. For six global mining companies, these discussions evolved into a formal global initiative in 2006 – the Earth Moving Equipment Safety Round Table (EMESRT).

The next step was to develop and implement a strategy for mining equipment users to engage with OEM's. The first meetings were with eight surface mining OEM's and these discussed the EMESRT design philosophies to develop an understanding of each other's perspective. Once this approach was confirmed as adding value the design challenges were expanded from surface mining equipment to underground coal and hard rock mining, along with exploration drilling.

In 2006, serious injuries and fatalities from access and working at height incidents from mobile equipment were common occurrences across mining companies and all regions. Working with OEM's, EMESRT confirmed customer equipment access and working at height requirements and these became the basis for improved design. By 2012, this approach had largely eliminated equipment access and working at heights hazards in new mining equipment.

Following OEM requests in 2008, EMESRT developed OMAT (Operability Maintainability Assessment Technique). OMAT promotes the use of EMESRT Design Philosophies by engaging mining equipment users in a structured task-based assessment methodology.

This was followed up in 2011 with the development of EMESRT Design Evaluation for Earth moving equipment Procurement (EDEEP) process for evaluating OEM equipment design during mining company equipment procurement. OEM's who apply this process can demonstrate that they are designing beyond standards, are applying task-based design reviews and are linking design features to priority issues.

Our vehicle interaction project commenced in 2013 continues. This complex industry level work is based on Design Principle DP 5 - 'Machine Operation and Control' and is further explained in this report.

After a decade of success, we undertook a formal strategic review in 2017, that saw the implementation of several important actions to sustain EMESRT. This work included confirming our success factors, standardising industry project management processes, and updating our strategic plan.

In 2018, EMESRT developed and piloted the Control Framework approach and this was applied to two industry projects as detailed in this 2019 report.

1.1 DESIGN PHILOSOPHIES: THE EMESRT BACKBONE

Background

The foundation of the EMESRT approach comes from our eight Design Philosophies.

These design philosophies are the basis of our engagement with OEM and third-party equipment designers, manufacturers and suppliers, our industry focus projects and the development of EMESRT tools, processes and other resources.

Each Design Philosophy states objectives, design outcomes and categorises relevant potential unwanted events.

The eight EMESRT Design Philosophies are:

1. **ACCESS AND WORKING AT HEIGHTS**
   Prevent harm related to access and working at heights specifically where there is a risk of falling including slip/trip hazards, sprains/strains, falls and failure to egress in emergency events to as low as reasonably practical including design considerations for gender diversity and foreseeable human error.
2. **TYRES AND RIMS**
   Prevent harm related to tyre and rim handling, mounting, material failures and installation to as low as reasonably practical including design considerations for gender diversity and foreseeable human error and material failures.
3. **EXPOSURE TO HARMFUL ENERGIES**
   Prevent harm related to exposure to moving machine parts, failure of hydraulic equipment or systems, and other energy sources, such as compressed air, heat, electricity, kinetic and gravity to as low as reasonably practical design considerations for gender diversity and foreseeable human error.
4. **FIRE**
   Prevent harm related to equipment fires incorporating suppression systems, safety equipment and placement of hydraulic and fuel lines to as low as reasonably practical including design considerations for human diversity (variability, capability and limitations) and foreseeable human error.
5. **MACHINE OPERATION AND CONTROL**
   Prevent harm during machine operation and control to as low as reasonably practical including design considerations for human diversity and foreseeable human error.
6. **HEALTH IMPACTING FACTORS**
   Prevent harm from exposure to health impacting factors to as low as reasonably practical including consideration in design for human diversity and for foreseeable human error.
7. **MANUAL TASKS**
   Prevent harm related to manual tasks during installation, maintenance and the operation of equipment to as low as reasonably practical including design considerations for human diversity and foreseeable human error.
8. **CONFINED SPACES AND RESTRICTED WORK AREAS**
   Prevent harm to people working in confined spaces and restricted work areas to as low as reasonably practical including design considerations for human diversity and for foreseeable human error.

Further information, including PDF files, are available on the EMESRT website - emesrt.org.

1.2 CURRENT FOCUS PROJECTS

Overview

At the end of 2019, EMESRT is supporting and leading the four industry focus projects. Managing this workload scaleup with what is largely a volunteer organisation is only possible because of decisions made at a 2017 strategy review to formalise the effective but semiformal project management processes.

The subsequent formalisation work now allows EMESRT project leaders and support personnel to lead and manage concurrent complex industry level projects, as detailed below.

1.2.1 INDUSTRY PROJECT 1: VEHICLE INTERACTION CONTROL IMPROVEMENT

This industry project is led by EMESRT Glencore representative Tony Egan.

Operating vehicles (mobile equipment) and driving present the highest mining industry fatality risk, at 30 to 40% of all incident reports with just over half the fatalities being pedestrians.

In mid-2013 it was clear there was significant confusion on the effectiveness and reliability of collision related systems throughout the industry. Following an industry workshop in September 2013 with a range of global representatives, it was evident that there was a need to focus attention on this emerging issue.

EMESRT combined its Design Principle DP 5 - 'Machine Operation and Control', and proven methodology to:

- Clearly define the problem (Vehicle Interaction is the problem, collision systems are controls)
- Understand and confirm the interaction scenarios and unwanted event categories
- Build a set of performance requirements to assist with the evaluation of Proximity Detection System (PDS) technologies on the market

Since then EMESRT has led and participated in industry-level initiatives with the common goal of improving the effectiveness and reliability of vehicle interaction controls in mining, including:

- The development of interoperability standards between third-party PDS suppliers and equipment supplied by OEM's – a common interface protocol allows PDS controls in mixed equipment fleets. This has led to the development of an international standard ISO 21815 Collision Awareness and Avoidance - Part 2 that formally defines the interface protocol
- In 2017, EMESRT prepared a paper seeking Collaboration with the ICMM Risk Committee, ICMM Collaborative Technology Acceleration Summits which has led to involvement and ongoing collaboration during 2019 for the ICMM Innovation for Cleaner Safer Vehicles (ICSV) VI programme
- Supporting and contributing to the industry review of the ACARP Proximity Detection System Validation Framework Project C26028. The outcomes of this project are being aligned to allow transition into ISO 21815 to formalise the methodology for all to reference

Unwanted Vehicle Interactions continue to represent the highest incident exposure in mining globally so the industry must maintain its focus on initiatives to achieve a sustainable reduction of this exposure.

Tony Egan
EMESRT Glencore representative

Project work continued throughout 2019 and has delivered these milestones:

- Supporting phase 3 of the ACARP Proximity Detection System Validation Framework Project C26028 that now includes alignment and collaboration with the University of Pretoria PDS testing work
- Contributions to Technical Committee TC 127 (Earth-moving machinery), Subcommittee SC 2 (Safety, ergonomics and general requirements), Working Group 22 and 28 (Collision awareness and avoidance)
- EMESRT financially supported the development of the ICSV Knowledge Hub for Vehicle Interaction, with the understanding that the underlying platform would be used on future EMESRT topic specific Knowledge Hubs
- Development of an integrated package of information and support material including a draft Vehicle Interaction Self-Review tool for baselining current mining user site performance before considering the introduction of new technology and other innovations
- Ongoing EMESRT support for the ICMM ICSV VI programme including attendance at workshops

The EMESRT vehicle interaction community is supported by monthly meetings and as required face-to-face workshops. Currently the community extends to over 140 individuals representing multiple organisations from mining companies, researchers, OEM's, third-party equipment suppliers, e.g. PDS and other interested parties.

More information about the vehicle interaction project can be found on the EMESRT website - emesrt.org.

Image: Light vehicle and haul truck incident.

Image: Light vehicle and dozer incident.

Image Copyright © 2018 Rio Tinto

1.2.2 INDUSTRY PROJECT 2: HUMAN FACTORS DESIGN FOR DIVERSITY

This industry project is led by EMESRT BHP representative Iain Curran.

Background

The general business case for increasing workforce diversity in mining is well established. Improving earth moving equipment design can remove significant anthropometric and other work demand impediments to establishing a more diverse mining workforce. This requires practical on-the-ground improvement of current operational practice and improvements in equipment design, particularly for maintenance tasks.

Project commencement

In May 2018, EMESRT coordinated a Human Factors Design for Diversity (HFDD) workshop. Workshop participants included a range of industry personnel including experienced maintainers and operators of both genders. The workshop was facilitated by Robin Burgess-Limerick, Professor of Human Factors within the Minerals Industry Safety and Health Centre at The University of Queensland, Australia. Attendees came from EMESRT members and non-members as well as technical experts in ergonomics and human factors.

The initiative was the catalyst behind the successful funding submission of an ACARP project proposal by Professor Burgess-Limerick titled 'Mining equipment human factors design for workforce diversity'.

The primary focus of the project is on designs which do not adequately accommodate potential operator and maintainer physical characteristics (static anthropometric variability); and with equipment operation and maintenance tasks which do not sufficiently accommodate potential variability in operator and maintainer strength, flexibility and reach distances (dynamic anthropometry).

Key objectives are:

1. To identify and describe design issues with current mining equipment which are a barrier to workforce diversity
2. To document and evaluate remedial control measures currently undertaken at sites
3. To communicate the results of the investigation to equipment designers and mine sites

> *It is important to understand whether the design of mining equipment unnecessarily restricts the range of potential employees who can safely and comfortably operate and maintain the equipment.*

Professor Robin Burgess-Limerick
The University of Queensland

Project progress

A review and critique of anthropometric design requirements for mobile plant and equipment currently documented in ISO standards and Mining Design Guidelines is being undertaken to provide a context for the subsequent investigations.

An extensive audit of mobile plant and equipment operated and maintained at Australian surface and underground mines is underway. These audits systematically examine the operational and maintenance tasks associated with a representative range of equipment types; document both the anthropometric variability limitations associated with the equipment designs, and undertake an analysis and evaluation of the musculoskeletal injury risks associated with the equipment related operational and maintenance tasks.

Next steps

The details of the audit strategy will be defined in consultation with the EMESRT Human Factors Design for Diversity working group. As well as documenting anthropometric variability limitations and highlighting manual tasks which require excessive force or extreme postures, the project will also document redesign actions which have been taken at sites to reduce these risks.

In 2020, EMESRT will schedule a HFDD workshop to discuss the project outcomes and identify next steps.

More information on the HFDD project can be found on the EMESRT website - emesrt.org.

1.2.3 INDUSTRY PROJECT 3: TYRES AND RIMS MANAGEMENT

This industry project is led by EMESRT Peabody representative David Champion.

Background

In 2007, EMESRT published Design Philosophy 2 (DP-2) focusing on Tyres and Rims. This project builds from this DP and the ACARP funded C14046 TYREgate: Risk Management Decision Support Tool for Earthmover Tyres and Rims - 2008.

Statistics indicate people from all sectors of the mining industry globally continue to suffer serious injury or death from unexpected incidents while maintaining large earth moving tyre assemblies. Most incidents involve stored energy release, catastrophic disassembly of wheel assemblies, tyre explosions from pyrolysis, crush injuries when moving tyres and wheels or working with mobile equipment.

Project commencement

In early 2019, EMESRT commissioned the development of a draft Tyres and Rims Management Control Framework and invited experienced mining industry personnel to be members of a Tyres and Rims working group.

The draft Control Framework was based on industry information, guidance, operation experience and know-how and included the review of:

- EMESRT Design Philosophy 2 – Tyres and Rims
- UQ - ACARP funded industry portals TYREgate and Riskgate
- Regulator information from multiple jurisdictions - incident reports, bulletins, publications analysis, and position papers, etc
- Operating site, company and industry documents
- Research and technical information, e.g. incident taxonomies
- Relevant Standards and Guidelines

In two facilitated 2019 workshops, 23 people representing 14 organisations listed below worked to review, amend and validate Version 1 of a CFw Baseline for Tyres and Rims.

Alcoa, Anglo American, BHP, Bluefield AMS, Caterpillar, Glencore, Otraco, Peabody, the Queensland Regulator, Rio Tinto, SIMTARS, South32, Thiess and Risk Mentor.

> *In early 2020, the working group focus will transition into sub-streams and correlate the functional performance requirements of the predominant exposure problems.*
>
> Dave Champion
> EMESRT Peabody representative

Project progress

- This project has already delivered a draft Tyre and Rim Management Self-Review tool, project plans including stakeholder management and has formed work groups to focus on:
  - Competent Personnel – to confirm recognised skill competencies for maintainers and supervisors
  - Tyre Handler Equipment Design
  - Wheel Assembly Design

See page 9 for the EMESRT CFw Tyre and Rims Required Operating State (ROS).

More information on the Tyres and Rims Management project can be found on the EMESRT website - emesrt.org.

Note: The project was initially led by Alcoa representative Ray Wilson who retired in November 2019. The EMESRT Advisory Group acknowledges the excellent work and dedication injected by Ray into this project since its formation and appreciates David Champion having been involved throughout the project taking on the lead role.

EMESRT CFw Tyre and Rims Required Operating State (ROS)

ROS-TR-01: Tyre maintenance practices for load shifting, component storage and mobile equipment interactions are effectively managed.

Tyre maintenance load shifting, component storage and mobile equipment interactions are safe and productive:

- *Clearances between mobile equipment and pedestrians are maintained*
- *Clearances between fixed equipment and personnel are maintained*
- *Lifting and load shifting is well planned and carried out without losing control*
- *Tyres and wheel assemblies are stored correctly so they cannot fall or roll*
- *Movements of tyres and other wheel assembly components are managed at all phases of their operating lifecycle from manufacture through to disposal*

Tyre maintenance includes Earth Moving Equipment as defined in Australian Standard AS 4457 as well as other rubber tyre vehicles such as highway trucks, light vehicles, cranes, etc.

ROS-TR-02: Wheel assemblies remain intact and equipment performs to expectations during tyre changes and all other tyre and rim maintenance activities.

Wheel assemblies remain intact and there are no unintended equipment failures through the tyre and rim maintenance cycle:

- *Personnel are always protected from high-energy and/or pressure related failures of wheel assemblies and associated equipment*

ROS-TR-03: Safe and productive operational use of earth moving equipment with inflated rubber tyres.

Operational personnel understand and make relevant contributions to ensure safe and productive tyre management through ensuring that:

- *Operating conditions minimise tyre damage*
- *Equipment operating practices meet and/or extend tyre life*
- *Tyre pre-start inspection requirements are clear and applied*

Operating personnel know how to manage high-energy wheel assembly failure situations, e.g. fires, heavy vehicle wire contact and lightning strike

ROS-TR-04: Tyre recycling and disposal practices for load shifting, storage, mobile equipment interactions and interaction with plant are effectively managed.

Tyre recycling and disposal practices for load shifting, storage, mobile equipment interactions and interaction with plant are effectively managed:

- *Clearances between mobile equipment and pedestrians are maintained*
- *Clearances between fixed equipment and personnel are maintained e.g. through guards and interlocks*
- *Lifting and load shifting is well planned and carried out without losing control*
- *Tyres are stored and transported so they cannot all or roll*

ROS-TR-05 Tyre maintenance, repair, reconditioning, recycling and disposal practices do not compromise the health of the people undertaking the work.

Tyre maintenance, repair, recycling and disposal practices do not cause health issues for the people involved.

Image sourced from Alcoa, Western Australia

1.2.4 INDUSTRY PROJECT 4: EQUIPMENT FIRES MANAGEMENT

This industry project is led by EMESRT Rio Tinto representative Mark Geerssen.

Background

In 2007, EMESRT published Design Philosophy 4 (DP-4) Equipment Fires. This project builds from that work.

Mobile equipment fires occur too regularly in the mining industry and present a potential fatality risk in surface mines and a potentially catastrophic risk for underground operations. There is also considerable cost in the recovery of the resultant damage for mining operators.

The cause of incidents mainly occurs in three categories, firstly in equipment design, e.g. separation of fuel from heat sources including fire system readiness. Secondly, issues with routine maintenance practices or the lack there of, causing degradation over a period. Thirdly, heat/fire suppression system detection and integration into base machine.

Fire detection and suppression systems are mostly designed, supplied and installed by third parties and not usually well integrated between OEM and third party supplier's designs. Maintenance of these fire suppression systems can be inconsistently applied and maintaining competent technician skills can be difficult especially for 24/7 remote operations.

Project commencement

In early 2019, EMESRT commissioned the development of a draft Equipment Fire Control Framework and invited experienced mining industry personnel to be members of the Equipment Fire Management working group.

The draft Control Framework build was based on industry information, guidance, operation experience and know-how and included review of:

- EMESRT Design Philosophy 4 – Equipment Fires
- Regulator information from multiple jurisdictions - incident reports, bulletins, publications analysis, and position papers, etc.
- Operating site, company and industry documents
- Research and technical information, e.g. incident taxonomies
- ACARP Funded UQ RISKGate – Fires topic
- Relevant Standards and Guidelines

In two facilitated 2019 workshops, 17 experienced and well qualified people representing the eight organisations listed below, reviewed, amended, updated and validated the draft CFw to become Version 1 of a CFw Baseline for Equipment Fires.

Alcoa, Anglo American, BHP, Glencore, Peabody, the Queensland Regulator, Rio Tinto, South32, and Risk Mentor

The Required Operating States for equipment fire management from the CFw are listed in the table on page 12. These were confirmed by workshop participants as being the minimum set necessary to deliver the business purpose of safe and productive operation of mobile equipment.

Having correlated the full spectrum of event triggers for Fires on Mobile Equipment in 2019, the working group will shift the focus to a targeted set of triggers that represent the major exposure.

Mark Geerssen
EMESRT Rio Tinto representative

Project progress

This project has already delivered a draft Equipment Fire Management Self-Review tool, project plans including stakeholder management and has formed work groups to focus on:

- Good Maintenance and Operational Practice
- Fire Detection and Suppression system design and maintenance
- Mining Equipment Design

See opposite page for the EMESRT CFw Equipment Fires Required Operating State (ROS).

More information on the Equipment Fires Management project can be found on the EMESRT website - emesrt.org.

EMESRT CFw Equipment Fires Required Operating States (ROS)

ROS-EF-01: Mobile plant design prevents interactions between flammable materials, fuel and ignition sources.
This required operating state applies for all mobile equipment. As required, additional design elements are included for approved for use underground applications This includes fuel, flammable materials and any other items which could combust.

ROS-EF-02: Mobile plant is maintained to a schedule and to OEM standards. Specific fire prevention and mitigation checks are part of the maintenance process. There are no early operational failures.
Mobile equipment is maintained to OEM standards taking into account the operating environment e.g. more frequent maintenance and servicing if required. Maintenance standards extend to third party modifications. Maintenance tasks are well planned and executed e.g. hot work is well managed. Maintenance processes include quality checks before equipment is returned to service.

ROS-EF-03: Mobile plant is operated productively and safely within operating design limits, avoiding fire or potential fire incidents.
Mobile equipment is operated within equipment design limits to avoid generating excessive heat or fuel loads.

ROS-EF-04: Local Response to fires or potential fires on mobile equipment - early detection with effective local response.
Mobile equipment operators and other workers are trained and capable to respond to mobile equipment fires. This includes following site emergency protocols if the fire cannot be extinguished.

ROS-EF-09: Effective Emergency Response beyond local response limits fire losses.
If there is a fire of potential fire on or around mobile equipment, then there is an effective emergency response that protects lives and property.

ROS-EF-05: Maintenance activities on or around mobile equipment do not cause fires.
Hot work on or around mobile equipment does not cause fires on mobile equipment, infrastructure, or work environment.

2. EMESRT SUCCESS FACTOR: EFFECTIVE GOVERNANCE PROCESSES

2.1 STRUCTURE

EMESRT is a safety by design organisation that facilitates equipment design outcomes at an industry level and its work program is based around coordinating the delivery of specific projects. Advisory group members, who are senior managers in their respective member organisations, make general and topic specific contributions based on their availability, professional and company experience and expertise.

EMESRT membership is limited to mining companies with contracted secretariat support provided by Mining3, a leading research organisation with global mining industry members. Further consultant support is sourced as required. Although membership is limited to mining companies, EMESRT recognises that without constant and broad consultation with industry related stakeholders is vital in achieving its purpose. That being to, ***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.***

EMESRT member companies pay annual membership fees, which are based on the 24-month rolling projected project load, which is updated annually in Q3. This allows for planning by member companies to make adequate funds available for the coming calendar year.

EMESRT provides a common coordination point for industry issues. This often involves connecting / integrating related work by other industry groups, e.g. instigating and facilitating industry workshops to develop the PDS Interface Protocol, which is being formally drafted into Part 2 of the ISO 21815 Collision Awareness and Avoidance Standard. Other areas are ACARP funded projects such as the Proximity detection system (PDS) Testing Methodology project (Mining3 and University of Pretoria), university research, other technical R&D by research organisations and sponsoring member participation in ICMM ICSV programme workshops.

> *Formalising our project management processes (scope, budget, resources) allows for transparency and the efficient and concurrent delivery of multiple projects.*
>
> EMESRT Advisory Group

2.2 RISK MANAGEMENT

Each year performance against the EMESRT Success Factors is reviewed at the annual planning workshop and outcomes reported to industry through this report. As required legal reviews that consider liability and anti-trust issues are undertaken for EMESRT projects and important communications.

EMESRT Advisory Group members are aware of managing anti-trust issues at all meetings and the information below is communicated in all EMESRT workshops and other industry forums. These processes have been in place since OEM engagement work commenced in 2006.

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 mining companies in the industry
- Share openly with all interested OEM's and other third-party suppliers
- Listen, consider and value OEM and third-party supplier contributions
- Provide information on leading practice to OEM's and third-party suppliers
- Share leading practice to assist mining equipment 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 designs
- Share OEM confidential information with other OEM's or third-party suppliers
- Impose adoption of solutions on member company sites

2.3 CONTINUITY AND RENEWAL

One of EMESRT's significant strengths is the continuity of representatives from member organisations. A core group of company representatives were responsible for establishing EMESRT and remain involved in 2019. Over that time, they have each made significant contributions to developing the reach and profile of the organisation and have developed and evolved the operational processes that can deliver successful industry level projects. Importantly, they have also established and maintained good relationships with senior managers in OEM and industry third-party supplier organisations.

One of our most important challenges has been capturing their decades of effective work so that EMESRT can continue beyond its original cohort of volunteers. Meeting this challenge has required formalising and updating EMESRT operational processes and introducing new EAG members to key industry players.

Our success in formalising operational processes is noted elsewhere and we are pleased to report that our two new industry projects established in 2019 are being effectively led by newer EAG members.

3. EMESRT PROCESSES

3.1 CONTROL FRAMEWORK OVERVIEW

Since 2017, EMESRT has been developing the Control Framework (CFw) approach and this is now a core operational process applied for all new projects. A CFw is highly iterative and adaptive process that begins with asking:

'What has to be in place for work to go right?'

It uses these organising questions to organise the knowledge and experience of contributors:

1. What is the business purpose?
2. What safe and productive operating states are required to deliver the business purpose?
3. What can cause failure in the operating states?
4. What are the business inputs that prevent or mitigate failures?
5. How are these business inputs?
    - Specified
    - Implemented and
    - Monitored

The approach that is aligned with Failure Modes and Effects Analysis, Human Factors and the definition elements of the ICMM Critical Control Methodology. It allows real-world inputs and experience to be mapped to the safe and productive operating states required to deliver business purpose. A CFw has these interlinked components:

- Required Operating States that deliver business purpose
- The Credible Failure Modes that can compromise Required Operating States - these are validated by incident experience
- The many Business Inputs that support the establishment and maintenance of the required operating states through preventing or mitigating the credible failure modes – these a mapped in from operational practice. These inputs can be categorised in three ways, either people or equipment or environment

Each Business Input has a clear title, an expectation of what it will do, its specification, a description of how it is implemented, and details of how its status is monitored.

Using the CFw approach establishes both a 'whole of system' overview and a structure that is linked to detailed operational practice. Working this way provides information and insights about the dynamic interconnects between personnel, equipment, the work environment, workgroups carrying out different tasks and overall coordination. This promotes the systematic identification of improvement opportunities. It is also flexible approach that allows the ongoing updating of all CFw component descriptions, content and links if new information becomes available and as new insights develop.

Applying the CFw approach for the EMESRT Mobile Equipment Fire Management Project produced the networked and hierarchical structure represented in the diagram opposite.

The Control Framework approach has been developed by EMESRT as a practical way to apply new control thinking.

EMESRT Advisory Group

Six Required Operating States

1. Well designed equipment
2. Equipment is maintained to standard
3. Equipment operated productively and safely
4. Effective local response for a fire
5. Appropriate emergency response
6. Disciplined hot work processes

Seven Credible Failure Modes Groups

1. Design
2. Maintenance
3. Operational
4. Detection
5. Local response
6. Emergency response
7. Reputation

(45 Credible Failure Modes in total)

Six Business Input Groups

1. Competent personnel
2. Fit for purpose equipment and materials
3. Operating environment
4. Supervision and monitoring
5. System optimisation
6. Incident response

(81 Business Inputs in Total)

Figure 1: Mobile Equipment Fire Management Control Framework Hierarchy.

3.2 KNOWLEDGE HUB

In our 2018 strategy review, the EAG confirmed that the successful delivery of complex industry projects also requires work to accelerate the development and adoption of the leading operational practice necessary to support the implementation of design and technology innovations.

This decision is confirmed in the introduction to this report as:

"We exist to reduce and eliminate injuries and fatalities in our industry, and we do this by: developing and sharing processes that support safe, productive and practical outcomes at operating sites."

In 2019, EMESRT provided financial support for the ICMM ICSV programs to connect a sophisticated information management application to a web environment. Key requirements for this project were end user ease of navigation to curated information and efficient database management to ensure that content remains current and available.

Based on the success of the ICMM approach, EMESRT will launch Knowledge Hubs for each industry project in early 2020 using the same platform. Each topic specific Knowledge Hubs will provide curated tools, case studies, reference information, links to relevant websites and other resources for all stakeholders. The key EMESRT navigation approach, the Journey Model below, reflects a project delivery approach that is expected to be relevant for personnel on operating sites.

More information and access to the Knowledge Hub can be found on the EMESRT website - emesrt.org.

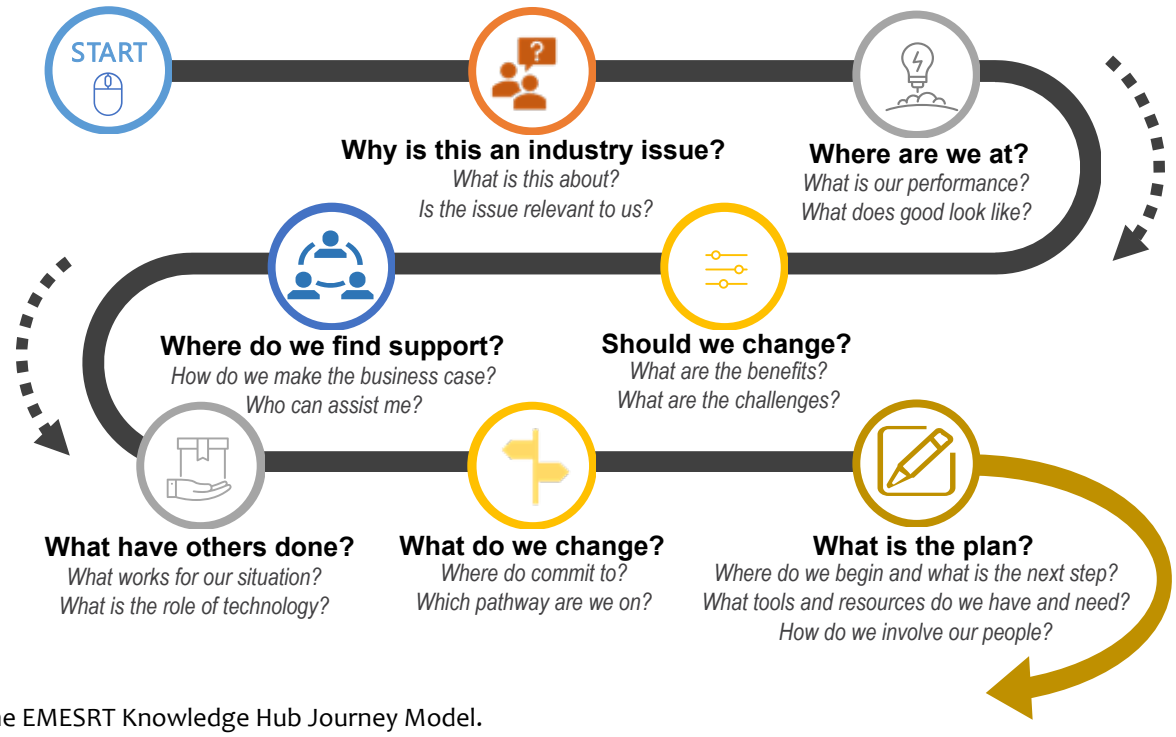


Figure 2: The EMESRT Knowledge Hub Journey Model.

The EMESRT Advisory Group meets face-to-face twice a year to update the 5-year strategic focus and develop the detailed 24 month plan.

EMESRT Advisory Group

3.3 STRATEGY AND PLANNING

Progress to plan

In 2019, Peabody hosted the annual EAG strategy review and planning workshop.

The review considered progress with each industry project, the status of work to formalise EMESRT operating processes, financial position and membership, industry influencing effectiveness, progress in adding value for EMESRT members and other industry stakeholders, performance against success factors and serving our purpose.

This report captures key outputs from these discussions and our 2020 – 2022 plans revolve around delivering successful industry projects, maintaining and raising our profile, developing and maintaining effective governance and operational processes.

4. EMESRT SUCCESS FACTOR: HAVING A REAL-WORLD BUSINESS UNDERSTANDING OF FINANCIAL DRIVERS AND LEVERAGE

Overview

Many EMESRT advisory group members are experienced company specialists who are involved in purchasing fleets of mining equipment for unambiguous commercial outcomes. Some have also worked for Original Equipment Manufacturers at different points in their careers.

This background ensures that they have a comprehensive business understanding of the financial drivers and processes for improving earth moving equipment design. Their experience also assists them as they lead EMESRT industry projects that define and capture good operational practice based on experience and knowledge of people representing many organisations.

The combination of deep EAG member commercial understanding, the use of EMESRT processes to capture and catalogue industry experience, and existing relationships with OEM and third party supplier organisations means that EMESRT is recognised as a trusted voice representing mining equipment users.

From this position EMESRT can influence supplier product design and with appropriate customer alignment through its member companies. This indirect and non-commercial approach helps both sides efficiently manage health and safety requirements when selling and purchasing new mining equipment.

At an EMESRT level, members can influence both the alignment of their own organisations and design direction for earth moving equipment suppliers. Through EMESRT's real-world business understanding, and long-term industry relationships provide significant level of influence for all mining equipment users through a high level of credibility with equipment suppliers.

5. EMESRT SUCCESS FACTOR: UNDERSTANDING THAT INNOVATION IS MARKET DRIVEN, NOT PUSHED BY TECHNOLOGY

Overview

The success of EMESRT since 2006 is based on a deep understanding that industry influence and collaboration is technology agnostic. This approach is supported by the fundamental EMESRT philosophy of defining the problem so that OEM's and third-party suppliers can design solutions that are targeted at the user defined problems.

It is also reflected in EMESRT's purpose. A relevant current example is the coordination support for the market enabling work of preparing and ISO interface standard between mining equipment and PDS technology, ISO 21815.

The well-accepted EMESRT approach is technology agnostic identifies the potential market by defining improvement opportunities, allowing OEM's and other providers to then develop their own business case for further research, development, manufacturing and marketing.

Image courtesy of Peabody, Queensland

6. EMESRT SUCCESS FACTOR: SENIOR MANAGEMENT (DECISION MAKER) ENDORSEMENT

Overview

The effectiveness of EMESRT's approach for engaging with and influencing organisational decision-makers is reviewed at each EMESRT strategy and planning review meeting.

While the industry role of EMESRT is well understood and regarded by senior OEM leaders other industry supplier organisations, it has a lower profile in operating companies, including those that are members. This uneven profile was reconfirmed during ongoing collaboration with the ICMM ICSV programme through 2019 where senior OEM manager participants consistently and publicly endorse EMESRT successes and its ongoing relevance.

This situation reflects a core underpinning EMESRT philosophy of focusing on the delivery of useful outcomes rather than working to lift its profile. However, we are working to increase the profile and influence with all stakeholders to increase our capacity and support the achievement of project outcomes. Our stakeholders include research organisations from around the globe, regulators, industry associations along with senior managers through to CEO level in operating mining companies, including our own members.

Much of this work involves providing information through annual reports, updating the EMESRT website and the development of Knowledge Hubs for each industry project that will provide curated resources and other information for operating companies.

The EMESRT industry projects remain the most important collaboration work being undertaken. Each project involves working with a cross-section of experienced people from multiple organisations to produce industry resources and it is this work that confirms the value add and ultimately endorsement of senior management decision-makers across our industry.

The intended outcome from this work are an effective, professional, consistent EMESRT stakeholder management processes that deliver successful and ongoing engagement with all stakeholders including senior managers in member companies.

APPENDIX 1: EMESRT 2019 SUCCESS FACTOR

SUCCESS FACTORS	EMESRT SUCCESS FACTOR DETAIL *(Adopted with permission from the Carbon Trust[1])*
1. Working at an industry level	*EMESRT promotes collaborative industry projects that deliver sector-wide benefits. Decisions on project areas are identified through rigorous, objective, fact-based analysis and engagement with stakeholders across the mining sector.*
2. Real world business understanding of financial drivers and leverage	*The EMESRT approach is to define problems so that OEM and third-party providers recognise the commercial opportunities.* *This indirect, non-commercial approach is achieved through influencing supplier product design and appropriate mine site customer alignment.* *The success of this approach pivots on the engineering and commercial expertise and experience of EAG members and their relationships with OEM and third-party suppliers*
3. Understanding that innovation is market-driven not pushed by technology	*The well-accepted EMESRT approach is technology agnostic identifies the potential market by defining improvement opportunities, allowing OEM's and other providers to then develop their own business case for further research, development, manufacturing and marketing.*
4. Governance - structure, funding, risk management, renewal and continuity	*EMESRT has established financial and operational governance processes that meet the requirements of member companies.* *EMESRT has active anti-trust processes and maintains the confidence of OEM and other third-party industry suppliers.* *It has an active risk management process based around an annual review of performance against its Success Factors. This annual review includes operating processes, purpose project delivery and organisational renewal and continuity.* *There are also regular reviews through the year on progress with industry projects.*
5. Senior management (decision maker) endorsement	*EMESRT is working to increase its profile and influence with all stakeholders to increase its capacity to deliver industry projects and other outcomes.* *EMESRT stakeholders include research organisations from around the globe, regulators, industry associations along with senior managers through to CEO level in operating mining companies, including our own members.*

PERFORMANCE SNAPSHOT

EMESRT PERFORMANCE IN 2019

In 2019 EMESRT industry projects increased from two to four. Each new project was chosen based on an analysis of member company and industry performance and compelling case improvement and innovation across industry has been developed for each.

EMESRT continues to actively support the ICMM Innovation for Cleaner Safer vehicles programme - a global collaboration between mining companies, OEM's and third-party suppliers and industry associations.

Two mining companies joined EMESRT in 2019 confirming the value of being an active member.

EMESRT continues to be recognised as the 'trusted voice of the industry' based on status active industry wide engagement since 2006.

For the EMESRT vehicle interaction control improvement project, EMESRT provided ongoing support for key enabling projects such as industry standards setting.

Each new EMESRT industry project in 2019 has involved industry suppliers in the Control Framework validation workshops and the establishment of subsequent workgroups.

The CFw approach systematically identifies innovation opportunities, as these projects develop, they will be shared with all interested stakeholders who can then make decisions about potential commercial opportunities.

Understanding business drivers (the market) from all perspectives informs how EMESRT operates. Practical examples from 2019 include the ongoing work to support the development of an ISO interface standard between mining equipment and PDS technology to allow future plug and play mixes of proximity detection systems and mobile equipment.

For 2019, using the CFw approach to develop a deep of current operational practice leads to the systematic review of both iterative and step change technology improvements.

This information will be further developed and shared in 2020. It is expected that business input functional requirements from this work will be reviewed by OEM's and other industry suppliers for commercial opportunities.

EMESRT member companies are committed to remain with the organisation through 2019. This positive position is underpinned by long term relationships between EMESRT member company representatives and OEM organisations.

EMESRT position as the credible and trusted voice of the industry has been confirmed by industry project workshop attendance and ongoing requests to contribute to industry level work such as the ICMM ICSV programme.

There is ongoing project oversight and contributions from all advisory group members. Project milestones are being achieved. Governance structures and common project management approaches are in place for all industry projects.

During 2019 EMESRT completed the formalisation of operating processes including the deployment of the CFw approach. Formal anti-trust processes are in place and are being applied.

EMESRT remains financially viable and processes have been developed to actively manage Secretariat and consultant support.

In 2019 EMESRT finalised an effective, professional, and consistent stakeholder management processes. These will be applied for all stakeholders, including senior managers in member companies.

The basis of the EMESRT approach is to provide value adding industry level resources and information. In 2019 this or the development of an updated EMESRT website and the creation of Knowledge Hubs for each industry project area. These will launch in early 2020.

[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).*

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