

**Earthmoving and Mining Industries
Presentation
to
Enabling Automated and Connected
Infrastructure Brainstorming Session**

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Agenda

- Introduction
- Industry Activity
- Differences in Industries
- Standards Activity
- Recent Products

Industry Activity

- Association of Equipment Manufacturers

Industry Sectors

Who is AEM

AEM is comprised of 1,000+ members, representing 200+ product lines, across 5 key off-road sectors.



Public

Product Safety

Who is AEM

Promote product safety through industry collaboration, openness, and consensus



Bring industry wide expertise together to discuss product stewardship, safety, compliance and sustainability



Administration of, and participation in, numerous international standard organization technical committees



Promote adoption of industry designed product safety initiatives



Public

Differences in Industries

We are not automobiles

Who we are not

- An automobile's main purpose is to transport people and goods
- Automobile infrastructure is standardized
- Access is unhindered
- Interactions with bystanders

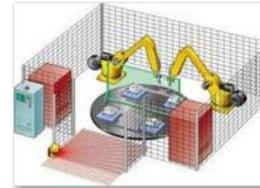


Public

We are not automated manufacturing machinery

Who we are not

- Fixed machinery
- Assembly lines
- Machining of parts
- Factory setting
- Static indoor, enclosed environment



Public

Industry Differences

We are Construction

Industry Sector

- Fully autonomous equipment has been deployed in certain applications
- Focused on greenfield settings, specifically infrastructure projects
- Applications involve independent machines working on their own
- Basic, repetitive tasks over large quantities of earth



Public

We are Mining

Industry Sector

- Controlled Access
- Machines perform work
- Machines do not transport people

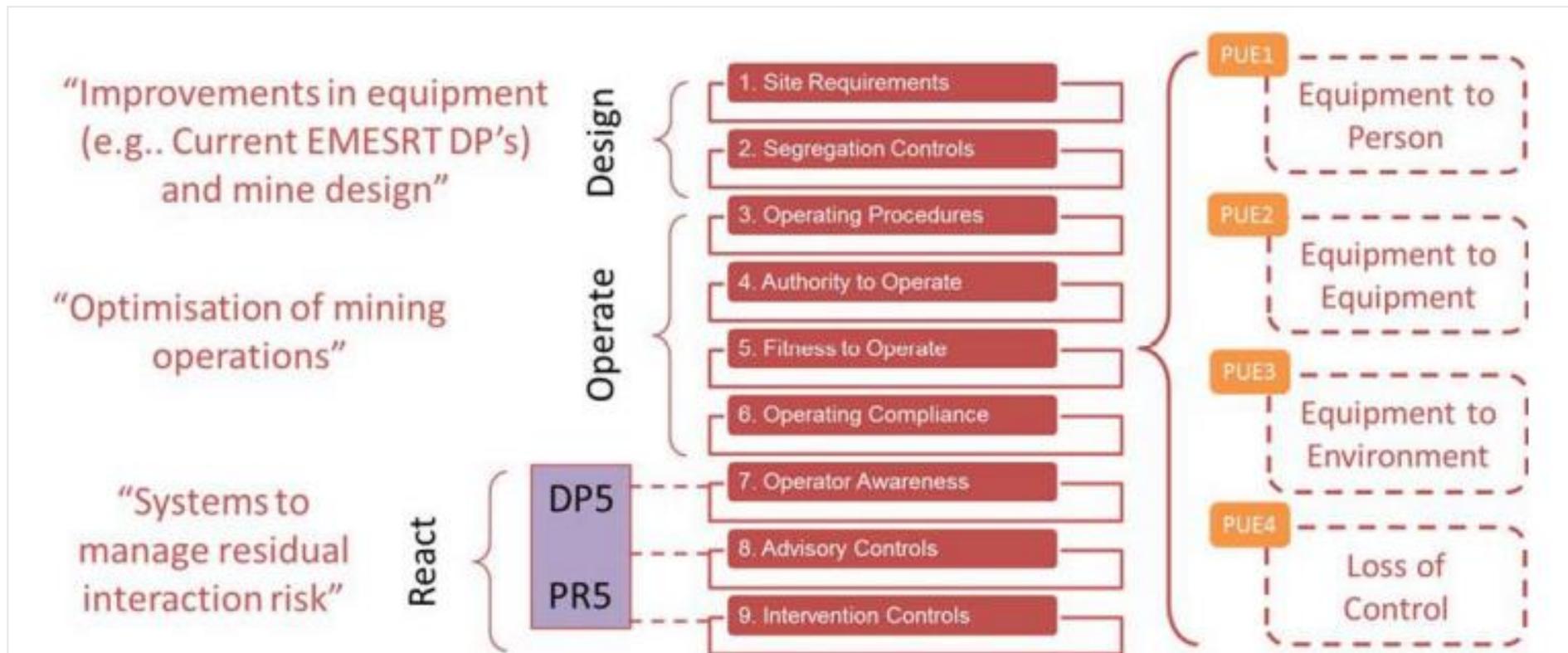


Public

Industry Activity

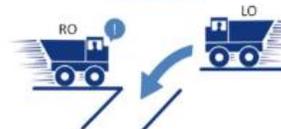
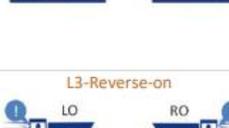
- EMESRT - Earthmoving Equipment Safety Round Table –

- Basically.....Get L1-L6 right....then look at your ability to address potential unwanted events to address residual risk through L7-L9 - [More information](#)



Industry Activity

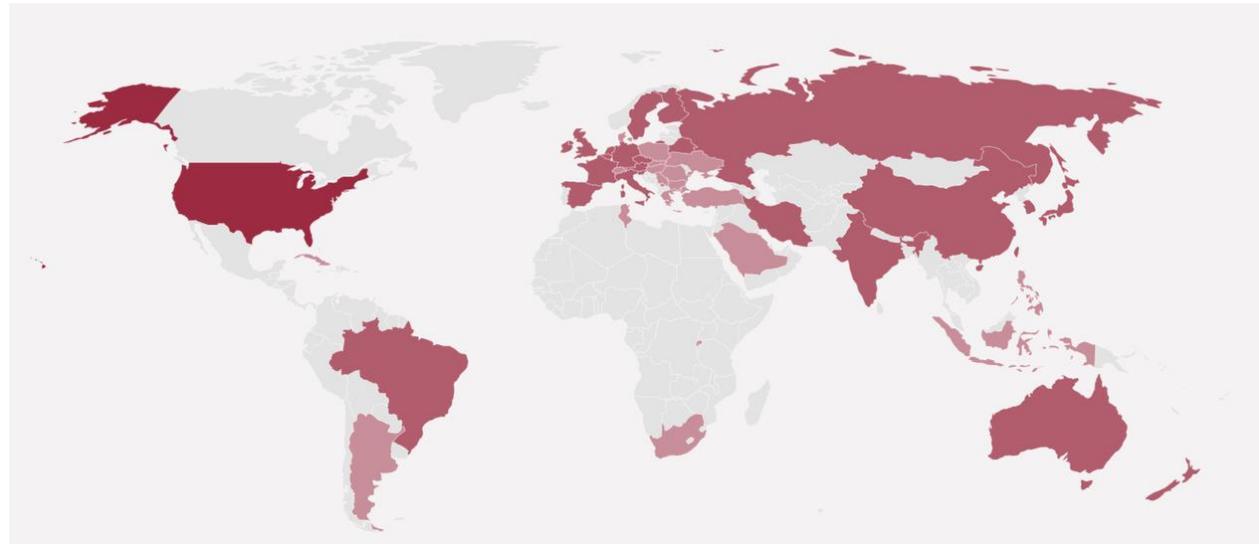
SURFACE VEHICLE INTERACTION SCENARIOS

| | | | | |
|---|--|--|--|---|
| <p>P1-Person (direct)</p>  | <p>L4-Dovetailing</p>  | <p>C1-Curving Head-on</p>  | <p>T2-Crossover</p>  | <p>V1-Void</p>  |
| <p>P3-Person (indirect)</p>  | <p>L5-Passing Head-on</p>  | <p>C2-Curving Dovetail</p>  | <p>T3-Junction</p>  | <p>V4-Loss of Control</p>  |
| <p>P4-Access and Egress</p>  | <p>L6-Passing Reverse-on</p>  | <p>C3-Curving Reverse-on</p>  | <p>T4-Intersection</p>  | <p>V6-Congested Area</p>  |
| <p>L1-Head-on</p>  | <p>L7-Overtaking</p>  | <p>T1-Merge</p>  | <p>O1-Obstacle</p>  | <p>R1-Swing</p>  |
| <p>L2-Backup</p>  | <p>L8-Blind Approach</p>  | | | <p>R2-Drop</p>  |
| <p>L3-Reverse-on</p>  | | | | |



ISO TC 127 Earth-moving machinery

- 24 Participating Countries
- 19 Observing Countries
- 184 Standards Published
- 18 Standards Under Development



Earth Moving & Mining Standards (Under Development or Recently Published)

| Augmentation | |
|----------------------------------|--|
| ISO 21815 Parts 1-5 | Collision Avoidance |
| ISO/AWI 22543 | Bystander awareness |
| Communication | |
| ISO 23870 Multiple Parts | High Speed Network |
| Autonomous | |
| ISO 23724 | Emergency remote stop |
| ISO 23725 | Fleet Management System Interoperability |
| ISO 3502 | Reference framework |
| ISO 3510 | Interoperability of teleoperated and autonomous |
| ISO 17757 | Autonomous safety |
| ISO 7334 | Taxonomy and vocabulary |
| Electronic Control Safety | |
| ISO 19014 Parts 1-5 | Functional Safety |

Alternative Power Gap

| | |
|---|----|
| Existing Standards that still need to be reviewed | 28 |
| Standards with known issues | 22 |
| Standards that could need to be created | 4 |

Other things on the plate

Cyber security, data privacy, AI

Recently Introduced Products

| Description | How it works | Results |
|--|---|---|
| <p>Operator Fatigue & Distraction Management Systems</p> <p><i>Nearly 80 percent of crashes and 65 percent of near-crashes involved some form of driver inattention within three seconds before the event. - NHTSA/DOT 2003 Report</i></p> | <p>Monitors eye-closure duration and head pose.</p> <p>Detects fatigue and distraction events utilizing AI</p> <p>Alarm for Operator</p> <p>Notifies 7/24/365 central monitoring center</p> | <p>97% REDUCTION in most significant fatigue events</p> <p>91% REDUCTION in distraction in distraction events</p> |
| <p>Smart Cameras</p> | <p>Object Classification utilizing AI</p> <p>Detection of People vs Detection of Objects</p> | <p>Reduction of False Alarms</p> <p>Reduction of Operator Fatigue</p> |
| <p>Electronic Fences/Avoidance Zones</p> | <p>Prevents operating machines from entering or reaching into restricted areas</p> | <p>Limits operation to approved areas</p> <p>Internal Traffic Control Plans (ITCPs) with Engineering Controls</p> |
| <p>Autonomous machines (ISO 7334)</p> <ul style="list-style-type: none"> - Haul Trucks (Level 4) - Dozers (Level 3) - Blast Hole Drills (Level 3) - LHDs (Level 3) - Excavators (Level 3) | <p>Eliminate the operator and reduce human error</p> | <p>Data from one OEM</p> <ul style="list-style-type: none"> • 600 autonomous haul trucks operating • 25 customer sites around the world • surpassing 5.9 billion tonnes of hauled material • 99,000 miles driven daily (equivalent of 4 times around the earth) • >127 Million miles (equivalent distance to Mars) • 7x24x365 • No lost time injury |