Preliminary Content Structure for Small Autonomous Haul Trucks Whitepaper | 2022

This preliminary content structure was complied from Small Autonomous Haul Trucks workshops and discussions where industry participants created and discussed the project plan, the biggest challenges of small autonomous haul trucks, and potential use cases/opportunities.

As adoption of autonomous systems increase in mining, small vehicle automation is becoming more affordable and accessible.

The objective of this project is to publish a collaborative white paper that can help surface mines with the adoption of small size autonomous haul trucks (100 tonnes or less) by providing common considerations and increasing awareness of challenges and opportunities that are specific to them.

Small sized autonomous haul trucks can be an option for:

- Different types of operations that do not use large mining-scale haul trucks.
- For large operations that are looking to automate their smaller equipment.
- For operations that are not ready for large-scale automation and need an entry point.

Based on the discussions had on the topic, some of the potential core content to include in the white paper includes:

Suggested Heading	Content Discussed	Relevant Notes
Taxonomy	• Requirements and vocabulary on small truck automation • Vehicle size • Classes of trucks from light to heavy • Brownfield and greenfield differences • Underground and surface differences • Truck payloads and payload operations • Rigid and articulated, scrapers • Loading and dumping options • Tipping strategies • Fleet management system of autonomous trucks and integration with current dispatch systems • What is the bare minimum? • Fleet management systems and mission control	• A participant commented on the taxonomy for clarity: "Taxonomy of vehicles sizes - why? size of market? clarity for new OEMs? like classes of trucks from light to heavy duty" • A participant commented asking if the scope is both construction and mining

Technology and Infrastructure	• Mine design considerations • Retrofitting or using on existing fleets • Dump site • Roads • Fragmentation • Fill factor • Communications infrastructure • Number of machines • Cybersecurity and data • Sensors and machine health • Automated grade control • Parameters and functional requirements • System integration • Supporting infrastructure • Level of independence of the machine (more machine autonomy/smarts, P2P comms) • Underground environment when GPS is not available • Vehicle to everything? Beacons, communications with other equipment onsite • System robustness: trucks need to be as smart as they need to be to perform their tasks • Interoperability (FMS/Traffic management) • Mine/quarry planning and scheduling considerations	**Challenges noted:** • Difficulty of matching loading equipment with smaller trucks on many large open pit mines/Operational readiness i.e. pass matching • Meeting production targets • Dimensions of open-pit roads (smaller roads) • local climatic conditions • Operate in more hazardous conditions • Evolving standards (SO) **Potential use cases discussed:** • Mine construction/road construction • Changes of mine layout • Interaction of different sizes of equipment especially at loading and tipping points • Interaction with other mine site equipment • Mixed Fleet Control (multiple vendors)
Processes and Operational Considerations	• Service and maintenance • Recovering from breakdowns • Traffic management • Logistics and productivity planning • Controlling large number of small machines • Start-up/shut down procedures • Continuous vs batch mine processes • Automated grade control is easier/more accurate	**Potential use cases noted:** • To right size the loading equipment and to increase the efficiency • Cost reduction/Commodity of parts/easier supply chain and access logistics • Considerations of what the operators were doing in addition to the operation of the equipment • Operations of the payload of the truck (water, shotcrete, blast media, consumables)

	• Operational considerations – dependency on fragmentation (sensitivity to oversize) • Cultural considerations and change management	
Staff training/workforce to maintain autonomous systems	• Dispatch team • Community and social impacts • Skills uplift – Operating/supporting/maintaining • Potential greater pool of skills to draw from knowledge on the autonomy components • Engineering resources are not in the quarry companies because they are in the mining companies • Operational considerations and experience with operating automated equipment • Contractor/haulage as a service to maintenance skills and safety – what is the reliability of skills being maintained	• How does this differ with small autonomous haul trucks? • Smaller workshops • Wear on tires • Automating services and maintenance easier on smaller vehicles, compounded when they are electric • Increases variability the number component types • Smaller overhead of operational considerations • Depending on the site, the cab of the loading unit could be the point of supervisory control of the smaller haulage
Safety	• Collision avoidance (i.e., more vehicle interactions) • Kinetic energy will be less or more efficient • Speed and mixed fleet speed considerations • Maturity on sites – interaction between automated and non-automated equipment • Road maintenance (both give and take) • Layers of protection	**Potential use cases discussed:** • Safety: Safety reporting for Autonomous control • Safety benefits from reduced human error, potentially safer smaller tyres for example • Social license to operate – lower emissions • Interoperability • Quality of service considerations of mission priorities
Next steps/future section	• Future use on-road • Where to dump material • Taking on-road technology and applying it to quarry/mine setting could be easier • Larger choice and supply chain options • Level 5 potential • Synergies with construction industry • Ownership structure of the machines, who is the operator, business models, support needed on the ground • Supplier and implementation partner	• This topic was originally noted as in-scope; however, later noted it should be included in future versions. • Social license to operate – carbon reduction potential – potentially compounds with electrification

	• How to implement small autonomous trucks	