

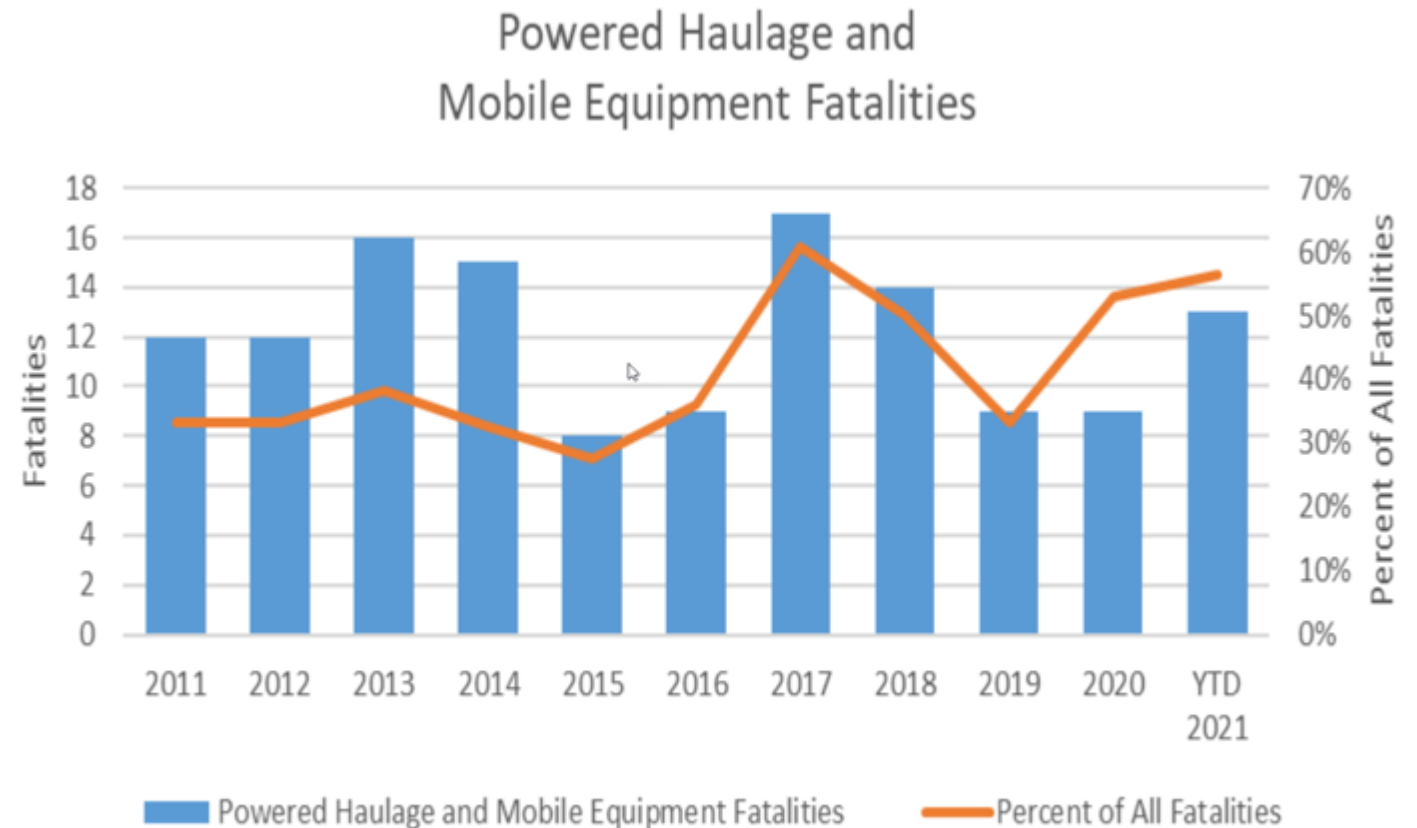
Lessons Learned From Haul Truck Operator Near-Miss Events



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Haul truck fatal accidents continue to be a significant health and safety concern in the mining industry

- Powered haulage and mobile equipment accounts for many fatal accidents each year
- Haul trucks are the largest contributor
(MSHA, 2018)
- Haul trucks account for 45% of mining equipment
(PR Newswire, 2015)



(MSHA, 2021)

MSHA Powered Haulage Safety Initiatives

- Identified as special safety initiative in 2018
 - Technical assistance
 - Awareness campaigns
 - RFI to industry stakeholders
 - New guidance and training materials developed
- Stand down for safety day held July 20th, 2021
 - 2021 injuries and fatalities at highest level since 2006
- Proposed rule to require written safety program in 2021

The screenshot shows the MSHA website header with the text "UNITED STATES DEPARTMENT OF LABOR" and "Mine Safety and Health Administration (MSHA)". The navigation menu includes "NEWS & MEDIA", "DATA & REPORTS", "REGULATIONS", "COMPLIANCE & ENFORCEMENT", "TRAINING & EDUCATION", and "SUPPORT & RESOURCES". The breadcrumb trail reads "HOME > NEWS & MEDIA > SAFETY INITIATIVES > POWERED HAULAGE SAFETY".

Powered Haulage Safety

Up far this year, nine miners have been killed and 185 have been injured in accidents involving powered haulage equipment such as shuttle cars, scoops, locomotives, front end loaders and more. Year to date, this is the highest number of powered haulage fatalities since 2006. The safety of mining's most precious resource – the miner – is a critical mission at the Mine Safety and Health Administration. That's why we are hosting a national Stand Down for Safety Day on July 20 focused on powered haulage and vehicle rollovers to help educate miners, save lives and prevent injuries. On July 20, all levels of MSHA enforcement staff will visit mines to meet with miners and operators to emphasize the need for adhering to best safety practices for powered haulage, vehicle rollovers, and miner training to reduce fatalities and injuries.

MSHA has also developed guidance intended to help miners, mine operators, and contractors prevent accidents caused by working with, on, or near powered haulage equipment. [The guidance contains best practices, links to videos and training resources, including other additional materials.](#)

Join us in getting the word out about mining hazards and how to keep workers safe. Share the information and resources on this page, including best practices, training presentations, and safety flyers. For more safety information, follow [MSHA on Twitter at @MSHA_DOL](#).

QUICK LINKS

TRAINING PRESENTATIONS:

- [CY2021 Mining Fatalities stakeholder presentation](#)
- [Underground Powered Haulage Fatality Prevention Practical](#)
- [Collision warning and avoidance systems](#)
- [Dump point safety – equipment considerations](#)
- [Dump point safety – operational considerations](#)
- [Seatbelt safety](#)

SAFETY FLYERS

- [Powered Haulage Safety](#)
- [Vehicle Rollover Safety](#)
- [Collision Prevention](#)
- [Conveyor Entanglement](#)
- [Seat Belt Safety](#)

VIDEO RESOURCES

- [Introduction to Powered Haulage Safety](#)
Stay safe with these best practices
- [Preventing Power...](#)

Research objective and primary tasks

Research Objective: 1) Inform future health and safety research related to haul trucks by identifying and characterizing health and safety issues through a systematic evaluation of accidents and injuries, operators' perspectives, and safety technologies. 2) Provide lessons learned, safety solutions, and training materials that can be directly used by industry.

Industry Engagement

- Visit and hold discussions with mine operators, manufacturers, industry associations, and other stakeholders to determine what the current state of the industry is and identify stakeholder concerns.

Fatal Accident Analysis

- Analyze human-machine interface failures that may have contributed to the occurrence or severity of a fatality involving a haul truck.

Mineworker Interviews

- Utilize cognitive task analysis methods to explore how various workers perceive haul truck hazards, skills and expertise, training, and how operators respond to challenging or nonroutine scenarios.

Training Materials

- Develop haul truck simulated accident recreations based on interview narratives.

Technology Readiness Assessment

- Assess the maturity of health and safety technologies (i.e., collision avoidance and warning systems).

Virtual Reality

- Design and develop a multi-player virtual reality (VR) training application. To leverage previous work, this task will target mine rescue teams and assess usability and acceptance in collaboration with MSHA.

Mineworker Interviews



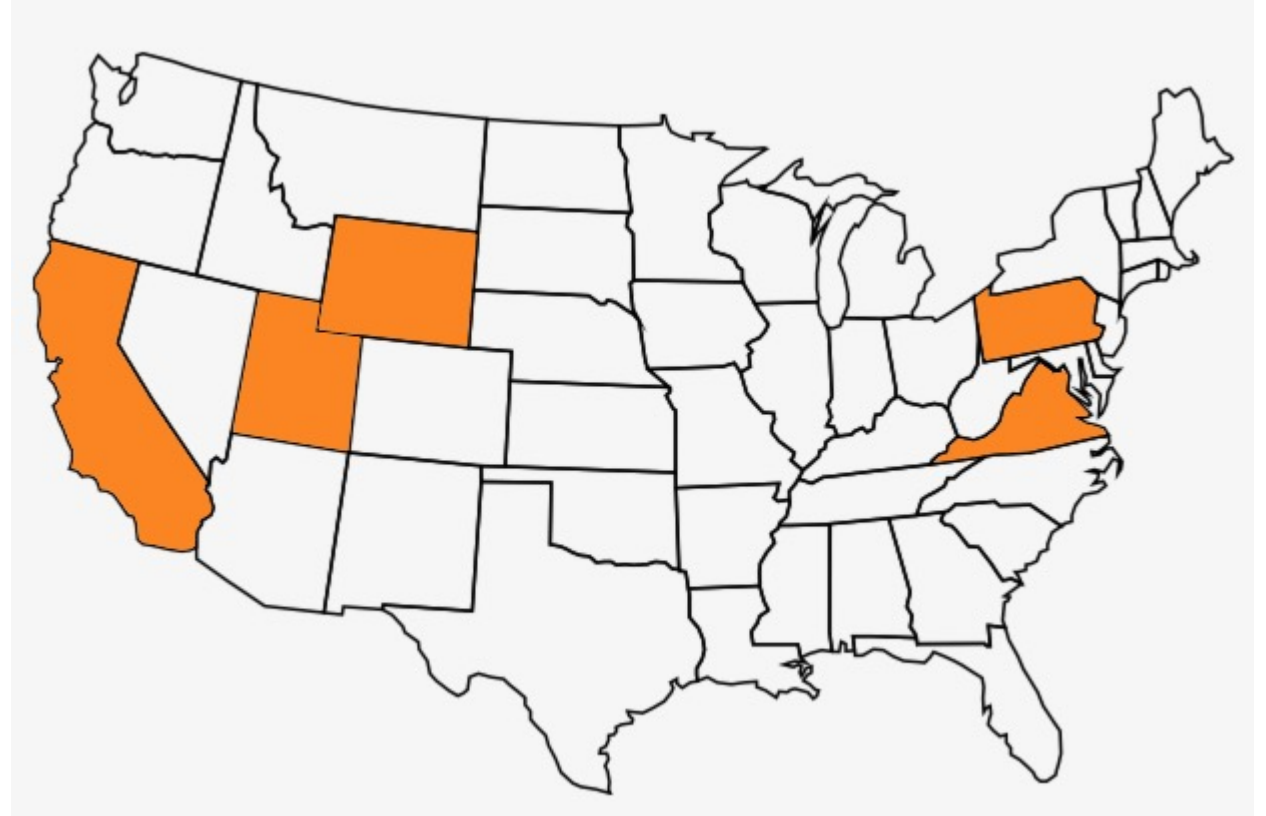
Critical Decision Method (CDM)

- Retrospective interview strategy to explore a near miss events (challenging or non-routine situations)
- Used to document specific details, challenges, subtle cues, and mental strategies (e.g., decision making, planning, and sensemaking)



CDM Interview Participants

- 11 Mine sites
 - Surface coal
 - Surface stone, sand, gravel
 - Surface metal
- 21 Haul truck operators
 - Mining exp.: 20 (2 – 46) years
 - Mine site exp.: 5 (1 – 36) years
 - Haul truck exp.: 15 (1 – 46) years
 - Haul truck site exp.: 4.5 (1 – 30) years

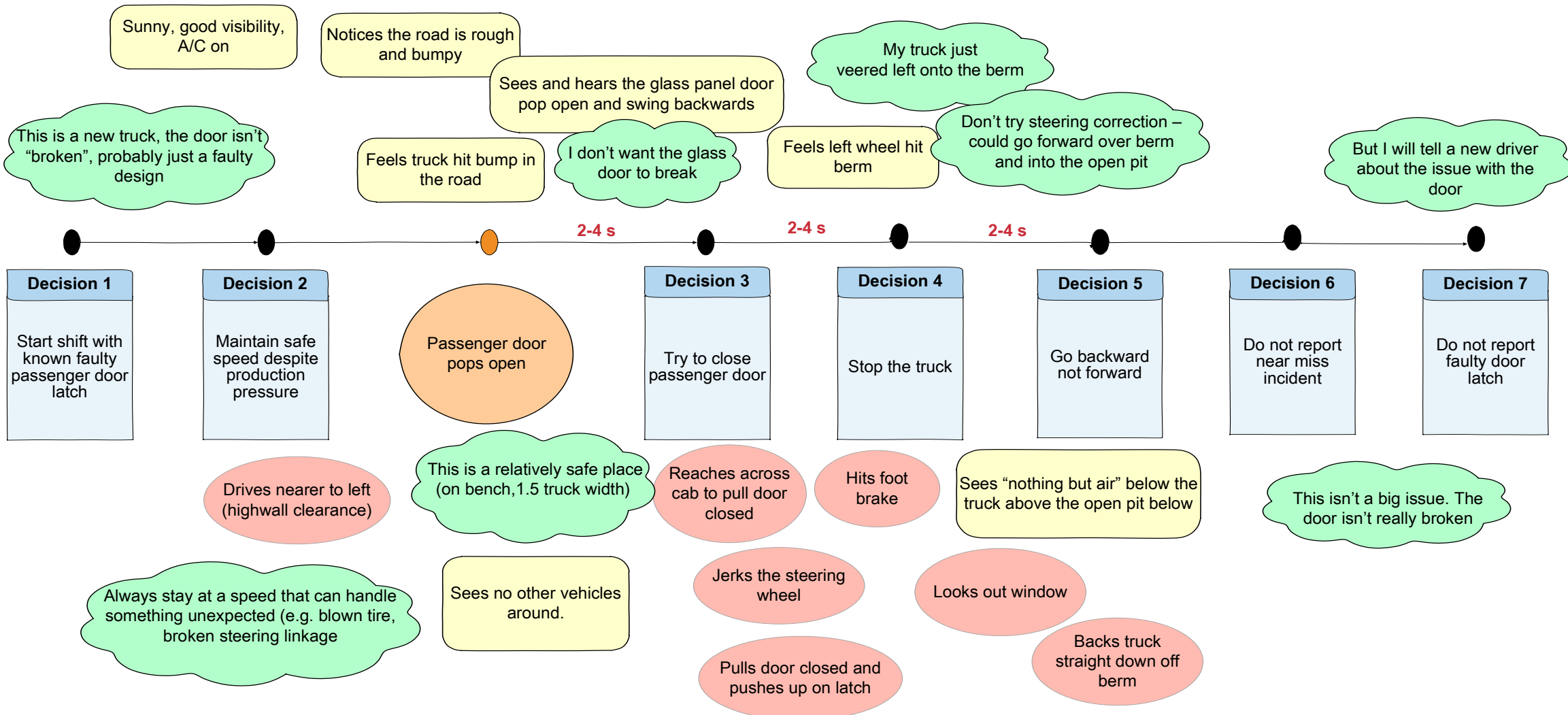
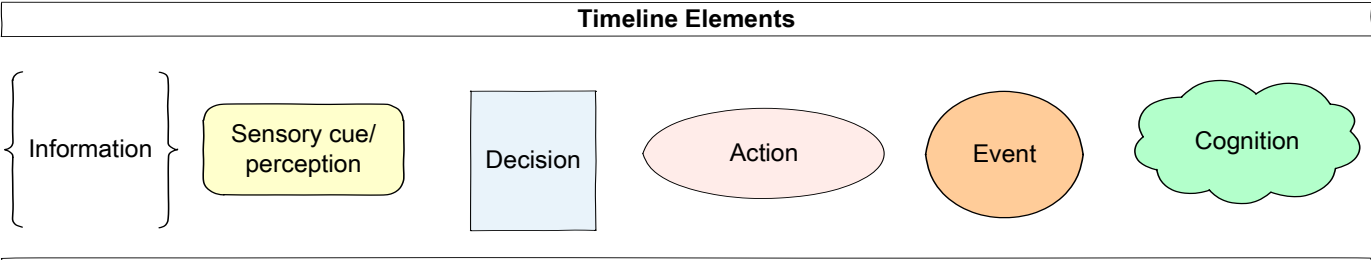


CDM Interview Steps

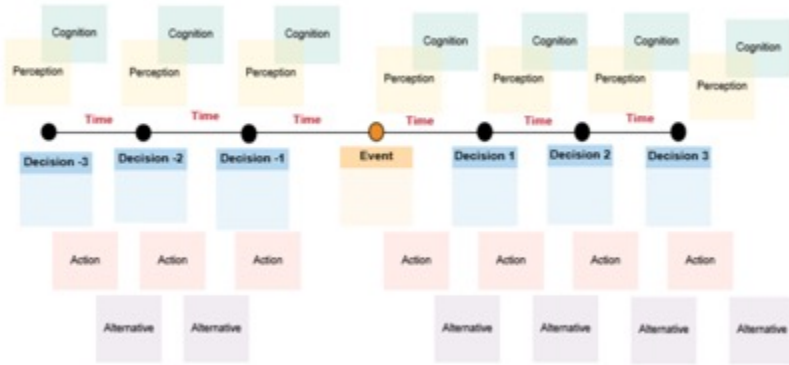
- Participant is asked to recall incident (challenging or non-routine)
- Participant asked to describe incident as a series of decision points on a timeline
- Deep dive into each decision point (gain perceptions, expectations, goals, judgements, confusions, uncertainties, etc.)
- “What if” questions

**Potentially Fatal Incident
Vehicle to Environment
Interaction**

{ 20 years ago
10 years HTO at time of event
773F }



Data Analysis: “Structured Approach” Adapted from Wong (2004)



1) Timeline

Incident Summary
 Date: 2004-04-14
 Location: [illegible]
 Description: [illegible]
 1. [illegible]
 2. [illegible]
 3. [illegible]
 4. [illegible]
 5. [illegible]
 6. [illegible]
 7. [illegible]
 8. [illegible]
 9. [illegible]
 10. [illegible]
 11. [illegible]
 12. [illegible]
 13. [illegible]
 14. [illegible]
 15. [illegible]

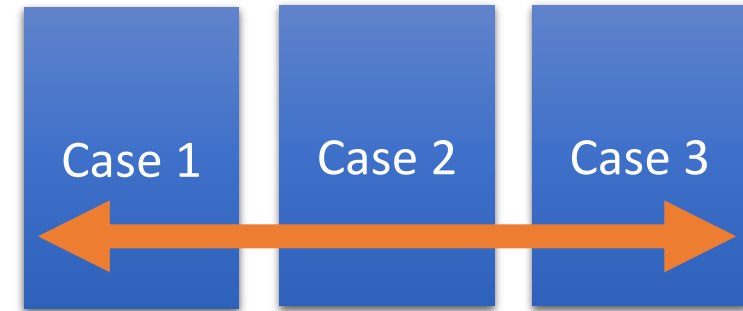
2) Incident Summary

A	B	C	D	E	F	G
1. Decision Analysis Table						
2. Situation/Context/Perception	Situational Assessment	Preceding Action(s)	Actions/Decisions	Why was action selected?	What for? - Higher Goals	Alternative action(s)?
3. Data with no light structures, only headlights and road sign	High shift, 20% visibility. Diving different truck the shift. Comfortable with truck. In the area and can go down #1 loaded. Plan made, ready to start.	Perform pre-shift inspection.	Truck is ready for operation, slow down to get to meet work group	Standard operating procedure. All start a start with group meeting to make plan for shift.	To ensure truck is safe to operate and to begin work day	
4. Sees right turn coming up	Lundrime is approaching. There is a truck to get one more load before the break. [illegible] light coming up.	Downshifts	Group decides to take clockwise route through beanfield right. Slow down to take right turn.	Blind turn	To ensure truck can proceed safely while loaded and through the area	To navigate turn safely. If hadn't thought to slow down, would have run into pit.
5. Sees unexpected oncoming right headlight approaching from left	The other haul truck is approaching from the wrong direction. Needs to maneuver to avoid collision. [illegible] on left side of road. No time to react.		Use foot brake	To stop quickly - natural reaction.	To avoid collision with oncoming haul truck	If other truck had LED headlights, it would have been seen sooner and the near miss would not have been so dramatic. Could have used emergency brake, but hadn't.
6. Feels truck sliding	Front wheels are locking up. Need to pull the hand brake and not turn wheel.		Pull hand brake	"Hand valves is better". Better to lock up back brakes than front brake.	To avoid sliding out of control and colliding with pit or sand pile	Other driver may have seen what was happening if worn't on.
7. Sees other driver "boom" past	Other driver on his phone, window down, looking the other way that other truck has passed, need to release brakes - especially foot brake.		Almost collides with oncoming haul truck. Release hand brake and foot brake	To come to controlled stop.	To stop safely without incident	
8. Sees other haul truck zoom	Safely stopped can leave truck to take position of truck and Out of danger. Safe to continue shift.					
9. Feels safe		Stop truck, park, put hazards on	Exit truck to take picture of truck and scene. Continue on to the dump	Safe to document near miss (SQIP?) Finish last run before lunch	For debriefing follow-up with HSDI call (if any)	To meet production goals
10. Was told supervisor would talk to the other driver	Company doesn't single out drivers so consequences for other driver will be minimal. Other driver was probably trying to rush to lunch - assumed the could be loaded truck robust interaction	Go to lunchroom, clock out	Call supervisor instead of confronting other driver	Confidentially report (SQIP)	Trained to go straight to management and avoid confronting coworkers.	To prevent incident from recurring and to hold the other operator accountable.
11. [illegible]			Asked loadman if he followed up with other driver			
12. [illegible]		View up incident on EDC card		Spoke to upper management about incident		

3) Decision Analysis Table

Goals, Sensory Cues, Perceptions, Decisions, Actions, Lessons Learned, etc.

4) Items of Interest

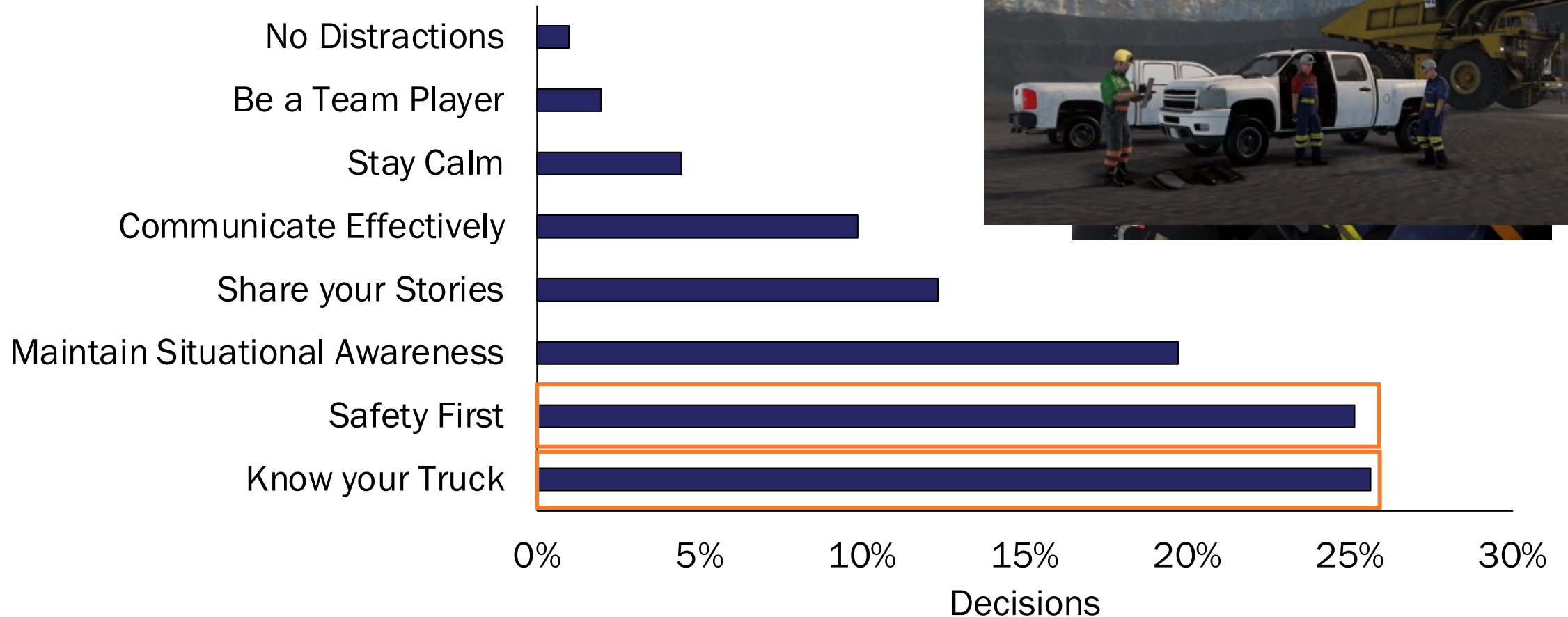


5) Common Items Across Cases

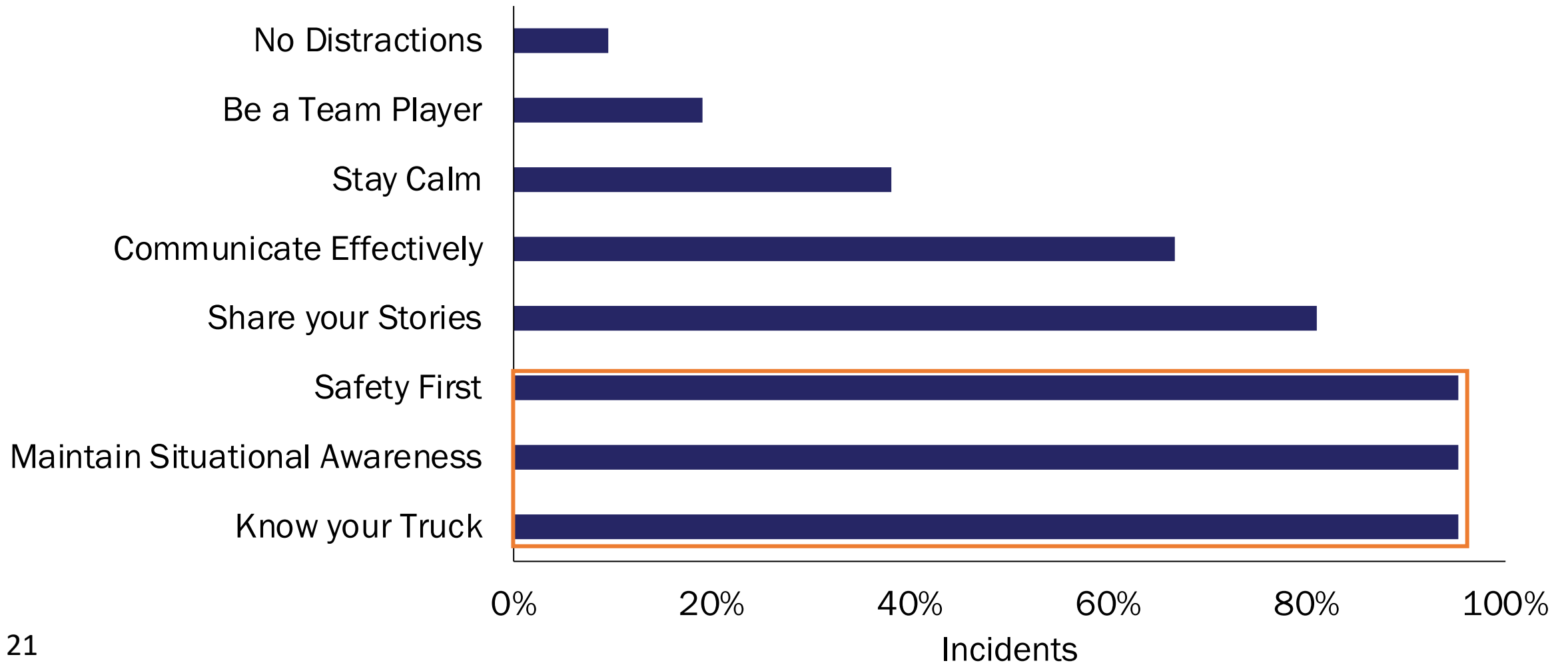
Wong, B. L. W. (2004). Critical decision method data analysis. In D. Diaper & N. A. Stanton (Eds.), *The handbook of task analysis for human-computer interaction* (pp. 327-346). Mahwah, NJ: Lawrence Erlbaum Associates.

Code	Definition
Communicate Effectively	Decisions to communicate (or failure to communicate) with co-workers in the moment to prevent an incident from occurring. (e.g., pre-shift communication, honk horn at worker)
Share your Stories	Decisions to tell (or failure to tell) management or other co-workers after an incident happens for the purpose of sharing knowledge or making changes to prevent similar incidents. (e.g., report near-miss)
Stay Calm	Decision to stay calm (or failure to stay calm). This includes decisions to not take any action or panicking and taking the wrong action. (e.g., stay in the cab)
No Distractions	Decisions to maintain focus on the task at hand (or failure to maintain focus). (e.g., look for a fallen water bottle)
Be a Team Player	Decisions to look out for the safety of others (or failure to do so). (e.g., get out of the way of other traffic)
Maintain Situational Awareness	Decisions made based on the ability to perceive elements in the environment, comprehend their meaning, project their status in the future, and planning accordingly (or failure to do so). (e.g., plan route around other vehicles, slow down to meet changing conditions)
Safety First	Decision to put safety first (or failure to do so). This includes decisions derived from attitudes, beliefs, and established procedures related to safety such as risk taking, following standard operating procedures, or cutting corners to keep things moving. (e.g., shuts down a road that is too slippery)
Know your Truck	Decisions made based on specific knowledge, training, or standard procedures on how to operate a haul truck (or lack of knowledge and training). (e.g., pre-shift inspection, know what breaks to use)

The most frequent decisions relate to safety and haul truck knowledge and behaviors



Safety First, Situational Awareness, and Know your Truck were required in almost every incident



Safety First: What you emphasize to your employees matters

- Safety culture is a set of safety-related **attitudes**, **beliefs**, and **practices** shared between employees, supervisors, and managers within an organization¹
- In challenging situations, mineworkers don't have a lot of time to make decisions
 - Do they know what to do?
 - Do they see a hazard as a hazard?
 - Do they feel comfortable doing it?
- Better safety culture improves safety behaviors
 - Repetition improves recall²
 - Promotion of safety has the greatest effect on safety behaviors³
 - Safety as a value⁴

1. Zohar, D. (2010). Thirty years of safety climate research: Reflections and future directions. *Accident analysis and Prevention*, 42, 1517-1522.

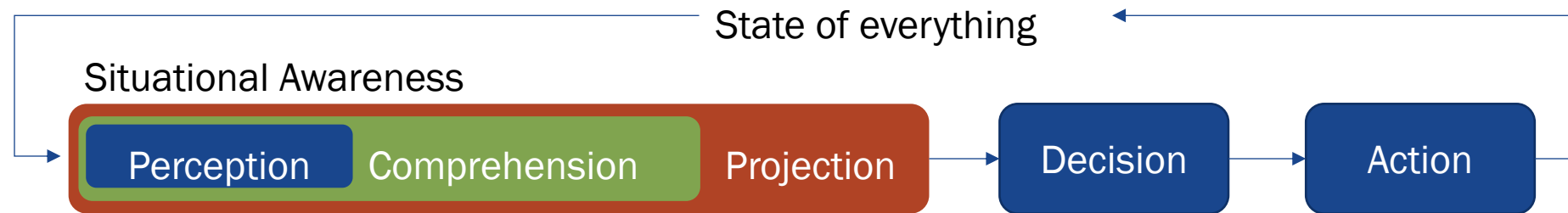
2. Scarborough, D. L., Cortese, C., & Scarborough, H. S. (1977). Frequency and repetition effects in lexical memory. *Journal of Experimental Psychology: Human perception and performance*, 3(1), 1

3. Molnar, M. M., Schwarz, U. V. T., Hellgren, J., Hasson, H., & Tafvelin, S. (2019). Leading for Safety: A Question of Leadership Focus. *Safety and Health at Work*, 10(2), 180-187. doi: 10.1016/j.shaw.2018.12.001

4. Geller, E. S. (1994). Ten principles for achieving a total safety culture. *Professional Safety*, 39(9), 18.

Situational Awareness: Understand the meaning of change

- Situational awareness is the ability to **perceive** elements in the environment, **comprehend** their meaning, and **project** their status in the future¹



- In challenging situations, mineworkers need to understand the situations
 - Did something change?
 - Do you know where everyone / everything is?
 - What does this all mean?
- Lack of situational awareness leads to accidents²
 - Avoid complacency
 - Respond to changes in routines
 - Understand the big picture

“If you notice that [a] berm is not the same height as when you were just back there at your last load, that's an indication that something's going on underneath the dump that we can't see.”

1. Endsley, M. R. (1995). Toward a theory of situation awareness in dynamic systems. *Human factors*, 37(1), 32-64.
2. Bellanca, J.L., Ryan, M.E., Orr, T.J. et al. (2021). Why Do Haul Truck Fatal Accidents Keep Occurring? *Mining, Metallurgy & Exploration* 38, 1019-1029 (2021). <https://doi.org/10.1007/s42461-021-00410-1>

Know Your Truck: Operators need to know how things really work

- **Competency** is the observable ability of a person to integrate their knowledge, skills, values, and attitudes to achieve a specific goal¹
- In challenging situations, mineworkers need to be able to quickly react
 - What is the truck capable of?
 - How is the truck going to respond?
 - What can I do to ensure optimal performance of the truck in this situation?
- Competency-based training helps to ensure skills are learned
 - Required task training is minimal (30 CFR § 46.7)
 - Training can vary by instructor and company
 - More technical information is needed (e.g., brakes)
 - Competence in critical knowledge and skills should be assessed through observation on the job in a variety of conditions

Use of VR for more effective storytelling
and incident analysis



“It’s the little things”

“So yeah, kind of a silly thing but those are the kind of things can get you in trouble here. **Just the little things.** Overlooking the little things.”

- Accident Type
 - Vehicle-environment
- Location
 - Haul road, surface SSG
- Description
 - Door pops open
 - Reaches to close
 - Almost goes over highwall



Lessons Learned from Near-miss Events

- Reveal critical details of a potentially fatal event (i.e., details that might not otherwise be found in a fatality report)
- Top 3 themes found across all incidents
 - Safety first (safety culture)
 - Situational awareness
 - Knowledge of truck

Thank you!

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