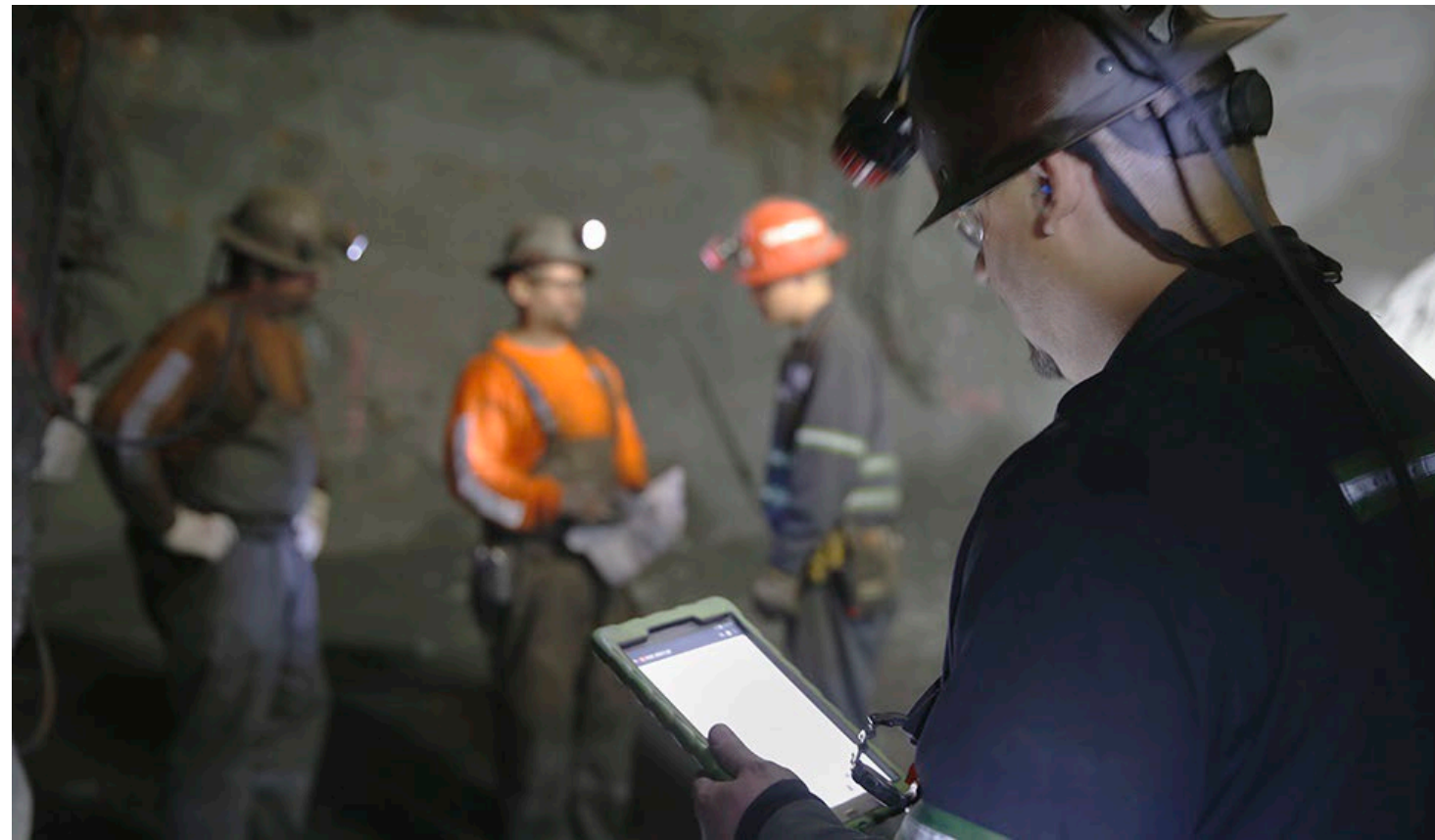


HECLA GREENS CREEK AUTOMATION

2023

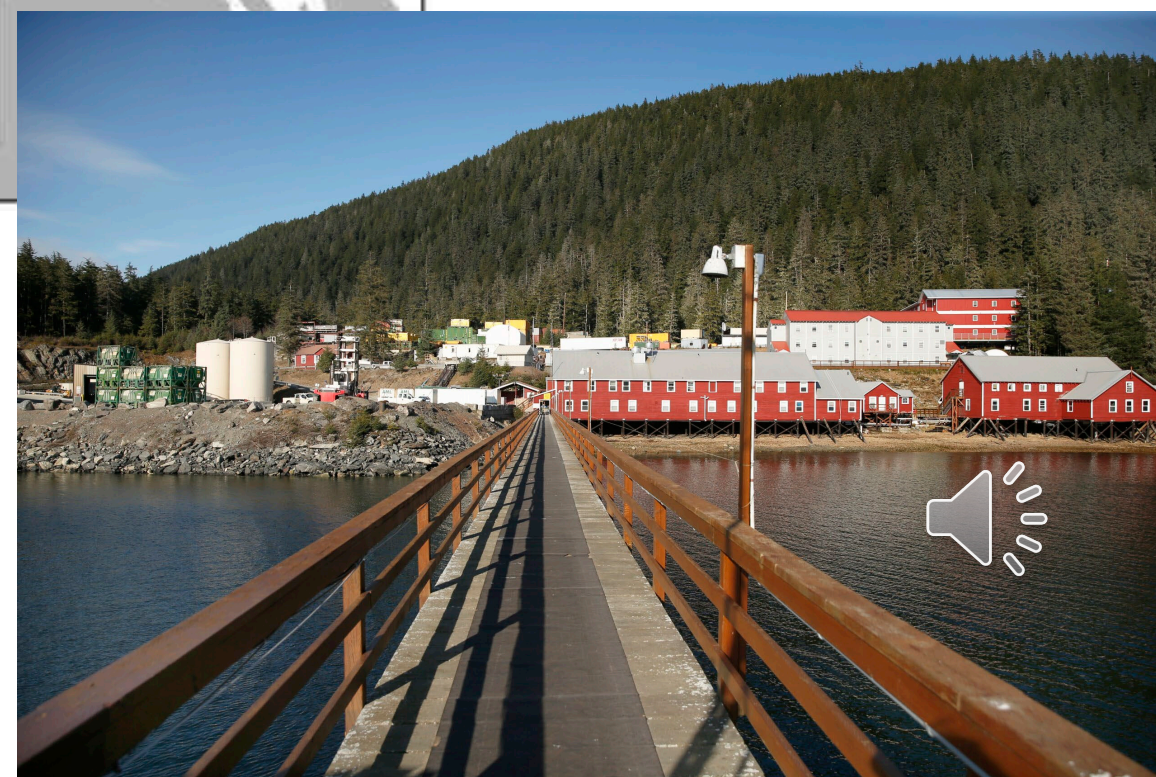
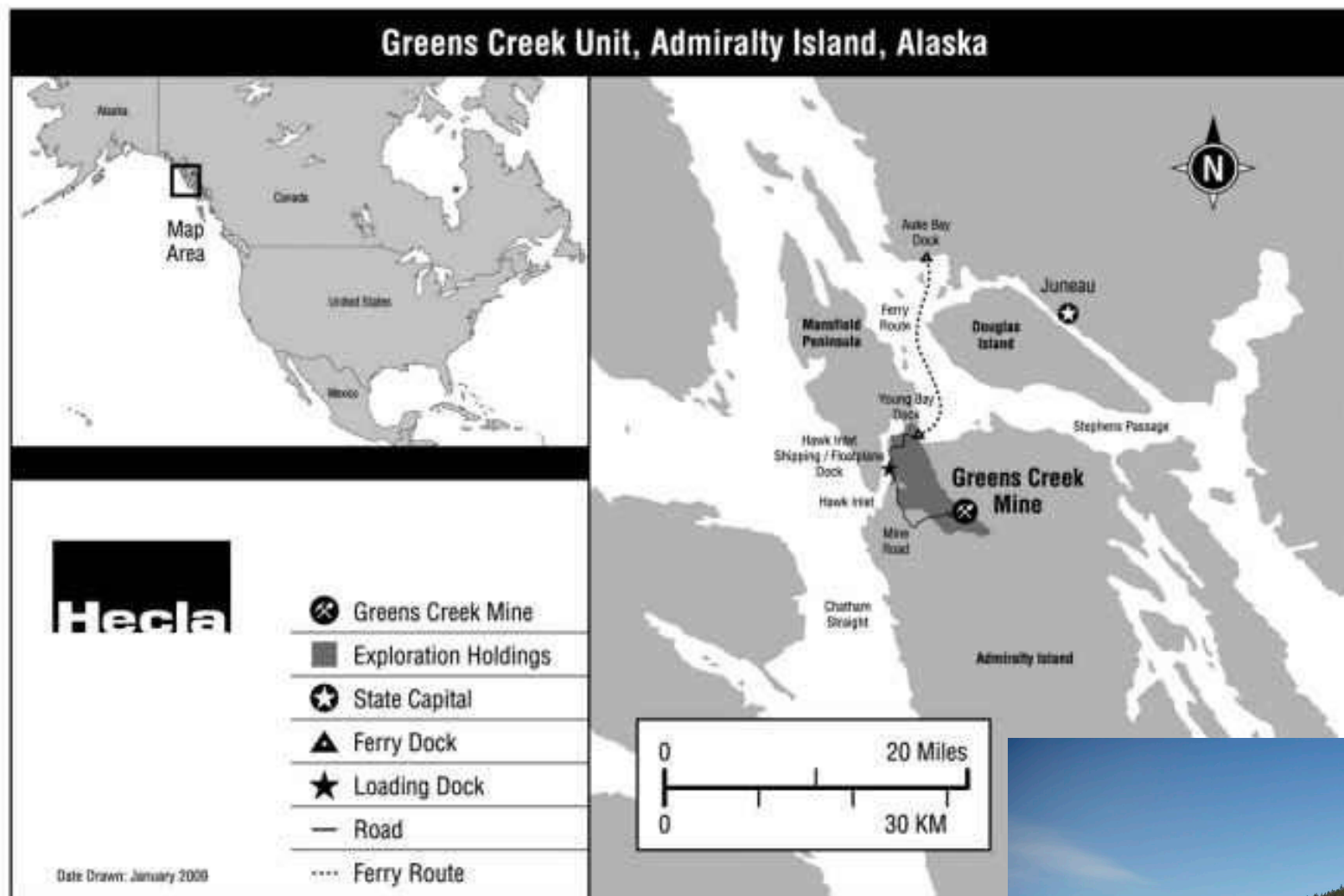


RESPONSIBLE. SAFE. INNOVATIVE.



GREENS CREEK MINE

JUNEAU, ALASKA



Greens Creek Automation

- Different Types of Automation
- How it Works
- Benefits of Automation
- Primary Obstacles
- Automated Loaders
- Automated Haul Trucks
- Automated Drills

Automated Haulage Route

- Project Scope
- Creating the Route
- Challenges
- Project Complications

Greens Creek Process Changes

- Safety Incidents
- Future of Automation at GC



Loaders



Haul Trucks



Drills



GREENS CREEK AUTOMATION

DIFFERENT TYPES OF AUTOMATION

Remote Control

- “Line of Sight” operation using handheld remote

Tele-Operated

- Operated remotely but still in full control of equipment

Driver Assist

- Operator has partial control, primarily over throttle/brake. Machine uses sensors/scanner to steer

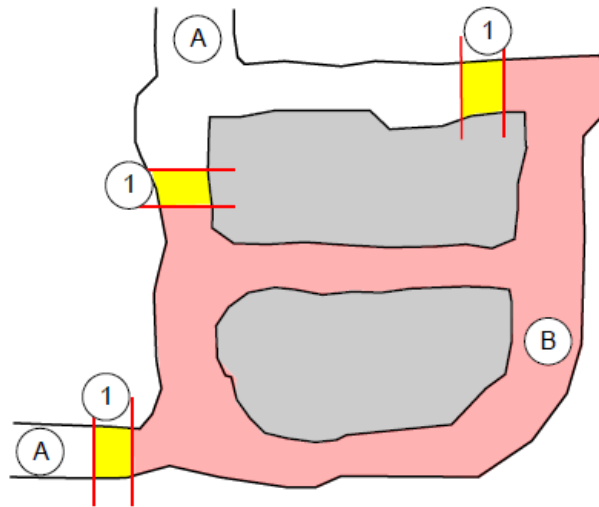
Full Automation

- Operator initiates commands and equipment completes tasks fully autonomously

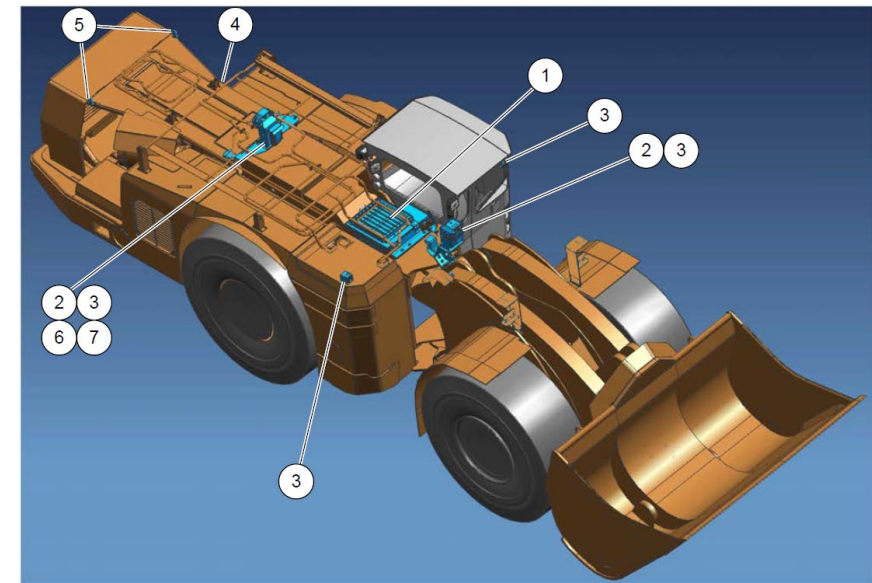
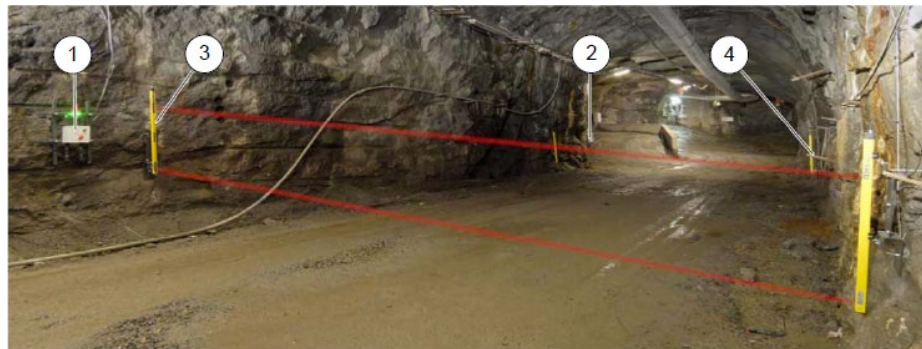


GREENS CREEK AUTOMATION

HOW IT WORKS



- Equipment is isolated in automation areas using Access Barriers or “gates”
- With the combination of cameras, LIDAR scanners, and sensors, the equipment can guide itself underground

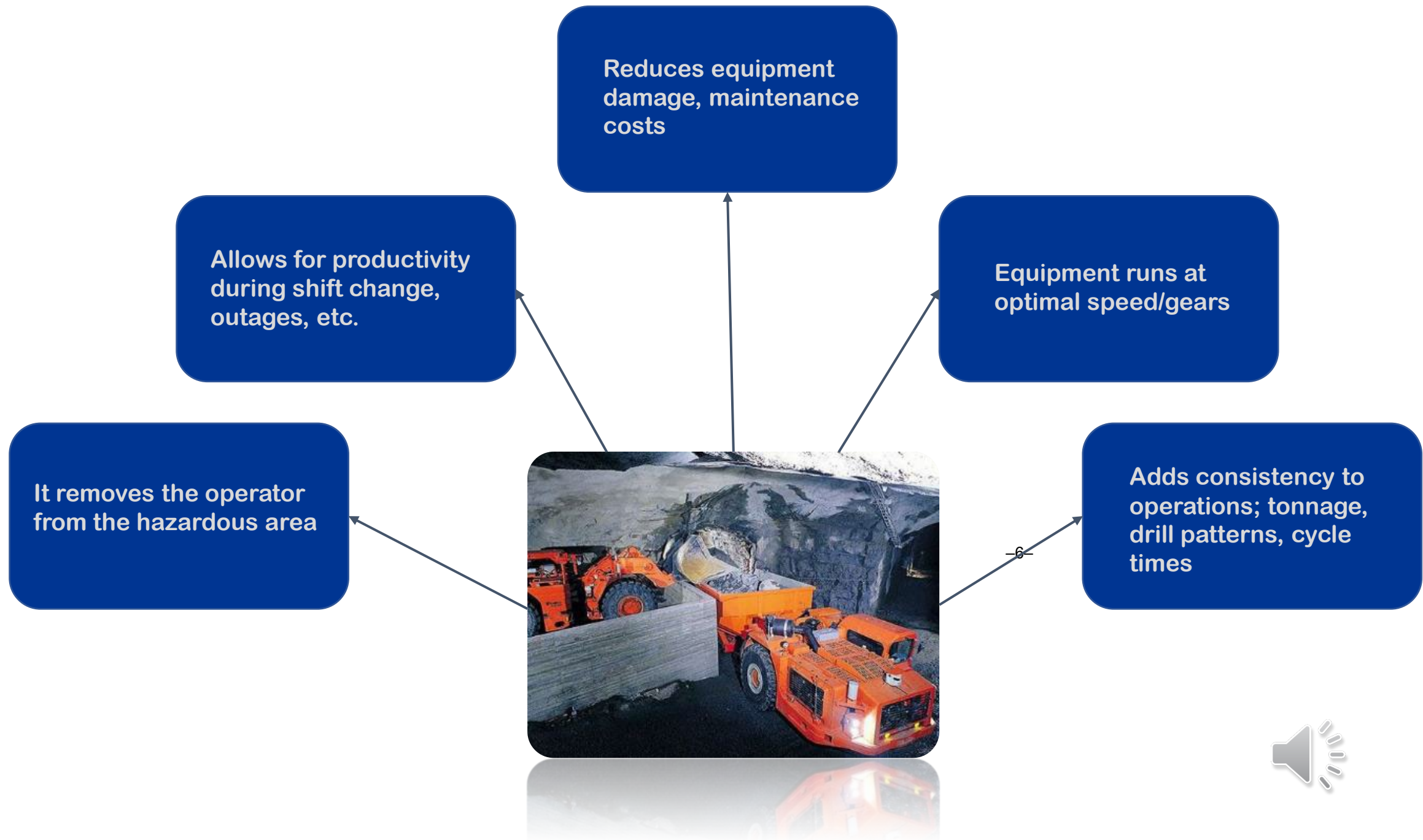


- 1 AutoMine Main Onboard box
- 2 Front/rear scanner
- 3 Cameras
- 4 Machine mode switch
- 5 Antennas
- 6 Machine status light
- 7 MineLAN client



GREENS CREEK AUTOMATION

BENEFITS OF AUTOMATION



GREENS CREEK AUTOMATION

PRIMARY OBSTACLES



Difficult to blend manual and automated operations

Many mines are already well established and not designed to accommodate automation

Significant initial costs, setup, and training

Keeping up with technology advancements

Requires change in culture and mentality

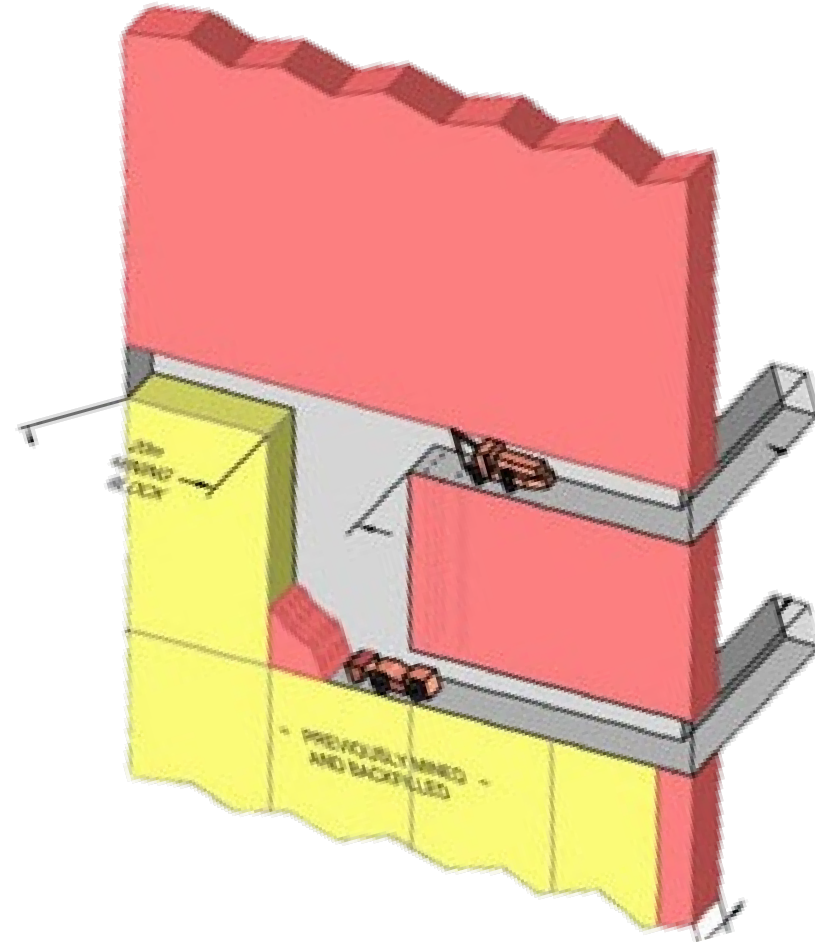


GREENS CREEK AUTOMATION

AUTOMATED LOADERS

Purpose

- Have an operator on surface running the machine in longhole stopes where there is no ground support
- Utilize the time between shifts (2-3 hrs/shift) to increase production
- Increase productivity by having one operator running multiple machines
- Decreased machine maintenance costs



Current Status

- Used to muck out longhole stopes both on-shift and between shifts
- No "Full Automation" is being pursued currently



GREENS CREEK AUTOMATION

AUTOMATED HAUL TRUCKS

Goals

- Operate the fully automated haul truck between shifts (2-3 hrs/shift), starting from the bottom of the mine
- Increase productivity by having one operator running multiple machines
- Decrease in machine maintenance costs

Current Status

- Not currently being utilized for automation. Project is temporarily on hold, pending technology advancements to improve the safety of interacting equipment.



Goals

- Setup multiple drills to operate on their own on-shift
- Increase productivity by having one operator managing multiple machines
- Decrease in machine maintenance costs
- Decrease in overbreak

Current Status

- Still in the implementation phase
- Operators are utilizing the pre-determine drill patterns, leading to a visible decrease in overbreak
- Still working towards having two drills setup and managed by one operator
- Some limitations include the need for operators to drill perimeter holes and lifters



AUTOMATED HAULAGE ROUTE

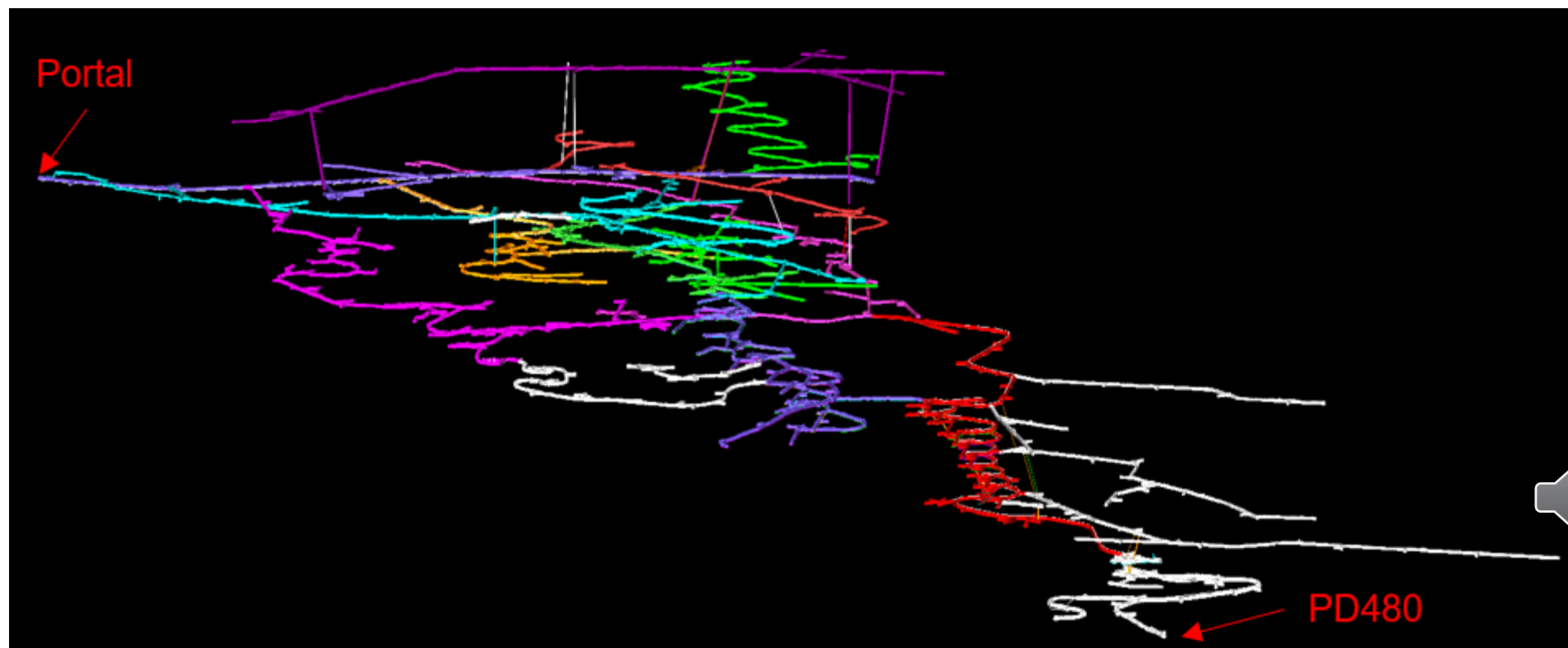
PROJECT SCOPE

Context

With the underground continuing to mine deeper, the haulage route from the bottom of the mine to the portal only becomes more time consuming and puts additional stress on equipment. From the portal to the deepest point in the mine is over 4 miles of haulage way, equating to ~40 minutes of tramming one way.

Solution

The goal of the automated haulage route was to create both a predetermined route and perfected equipment operation sequence. The automated truck will be setup to tram material from the bottom of the mine to the portal in between shifts during blasting.



AUTOMATED HAULAGE ROUTE

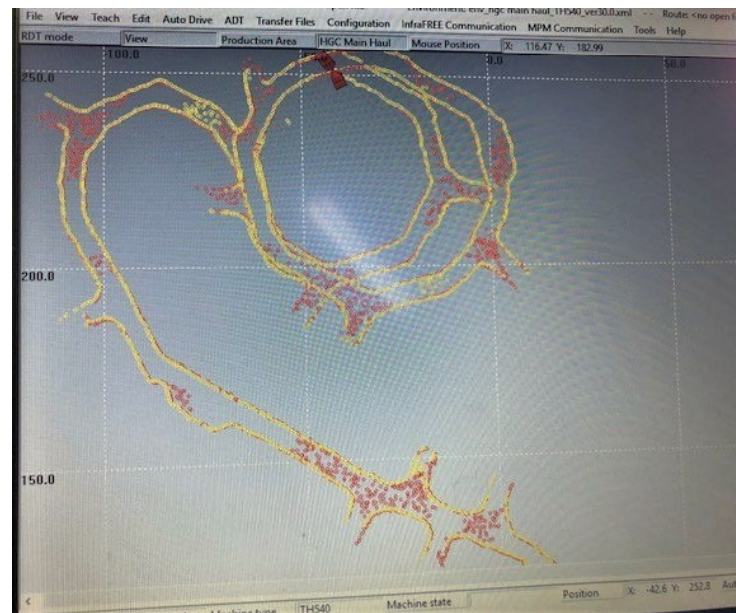
CREATING THE ROUTE

1. Building the “map”

- The initial route map was created by operating the equipment while it was guiding itself in tele-assist mode.
- This was able to be done on-shift, as the operator had full capabilities to stop the truck at any point.

2. Editing using a virtual truck simulation

- The route underwent initial editing and “validation” using the Sandvik RDT truck simulator.
- This testing eliminated a significant number of errors in the route upfront without requiring the use of the real haul truck.
- This initial testing also allowed for custom modifications to be made to the planned speed and gears used along the route to minimize the stress put on the truck.



AUTOMATED HAULAGE ROUTE

CREATING THE ROUTE

3. Final editing and field testing

- The new truck route was tested by running in full automation mode.
- Operating in the field allowed for final validation of each segment of the route to determine **is** ability to operate safely.
- This was able to be done on-shift with an operator in the cab to stop the truck if necessary.

4. Results

- By the end of the project, we were able to produce a completed and validated haulage route. Unfortunately, due to time constraints and the logistics of the shift change procedures, we were unable to run the full route in one session. We did, however, complete both halves of the route on separate days with no issues or obstacles along the route, totaling **at** 4.2 miles.



PROJECT COMPLICATIONS

- **Logistics**

- Due to the age of Greens Creek, most of the ramp system was not mined with larger or automated equipment in mind. This made certain sections difficult to validate with the smaller drift dimensions and sensitivity of the equipment sensors.
- A significant portion of the work was completed on-shift. This led to several delays in an attempt to minimize the disruption to the operations group.
- Due to the closure of the entire ramp system during shift change, numerous groups were impacted by the route validation and testing. This led to some push back from departments to open the ramp system to minimize the amount of lost work time.

- **Personnel**

- We would need to increase the number of staff to support the program, i.e., electricians to maintain the infrastructure underground and trained operators dedicated to running the automated equipment.



PROJECT COMPLICATIONS

- **Worker “buy-in”**
 - Gaining “buy-in” from the workers to help facilitate the project was difficult at times. The route project required cooperation and assistance from multiple groups and would not have been possible without them. There was occasional pushback that limited the progress of the testing.
- **Truck Loading Infrastructure**
 - A significant roadblock to the success of the haulage route is the lack of truck loading methods in the bottom of the mine. The mine currently does not have an efficient way to load the trucks and have them ready to tram to the portal.
- **Technology**
 - To see the most benefit, the automation technology needs to be able to safely work in conjunction with manual operations
- **Lack of Automation Standards in Industry**
 - There is currently a lack of standards and regulation regarding automation in mining. This forces sites to create their own standards that may inhibit progress and force them to abandon efforts to innovate.



SAFETY INCIDENTS

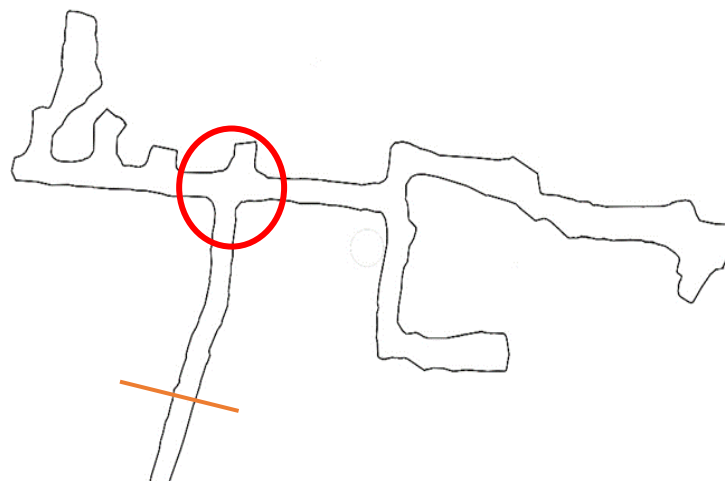
Setting up Automated Equipment with Personnel in the Area

Context

- Several incidents occurred where automated equipment was setup in an isolated automation area that had multiple working faces
- The root cause of the incidents was the failure to follow proper heading clearing procedures

Solution

- Temporary shutdown of all automation operations
- Modification to the Standard Operating Procedure for heading clearing to include automation
- Re-train all underground mine crews on the new SOP
- Implementation of an Automation Clearing Checklist



Edit entry

Date: 2023-08-29 05:03

Clearing Miners: Lee,Adam (70661) x

Shifter1: Tilton,Brian (70407) x v

Shifter2: Mcnaughton,Kyle (70028) x v

Chair Setup Operator: Wheaton,Bret (70981) x

LoaderOperator: Lee,Adam (70661) x

Location: 818/795D F1 LH v

Equipment: LR78 v

Work Instructions: Automation Setup

OutsideStationSetup1: Help

MineDash Checked: STOP GO

Area/Machine Selected: STOP GO

Gate Button Toggled: STOP GO

Clearing Miners: Help

Heading(s) Cleared: STOP GO

Machine Setup: STOP GO

Gate Set: STOP GO

Shifter Notification: STOP GO

OutsideStationSetup2: Help

MineDash Checked: STOP GO

Acknowledged and Activated: STOP GO

LoaderOperator: MineDash

MineDash Checked: STOP GO

Acknowledged and Activated: STOP GO

Shifter Notification 2: STOP GO

Update

paadmin4

SAFETY INCIDENTS

Automated Haul Truck Stopped on the Ramp without chocks

Context

- During testing, the haul truck would stop on the main ramp without the additional safety feature of chocks or the ability to “rib” the equipment.
- Depending on the location of the truck, personnel could have access to the ramp below the unsecured equipment, putting them at risk.

Solution

- Truck operator notifies the shifter of the truck’s location prior to releasing personnel underground.
- The shifter sends down someone immediately to chock/move the equipment and notifies all underground personnel to avoid the lower side of the ramp until the truck is moved



SAFETY INCIDENTS

The Use of In-House Field Cabinet Boxes

Context

- In order to increase the number of automation areas available for operations, we needed new field cabinet boxes for each area. To cut costs, we found that we could build the field cabinet boxes in-house at a fraction of the price.
- A pre-check test was being done on the gate during the haulage route project and it was noted that once the gate was set and tripped, it did not break the safety signal and shut the machine down like it was supposed to.

Solution

- Sandvik recommended that we use the products provided by Sandvik, as they meet and/or exceed safety standards in the industry.

Sandvik Field Cabinet



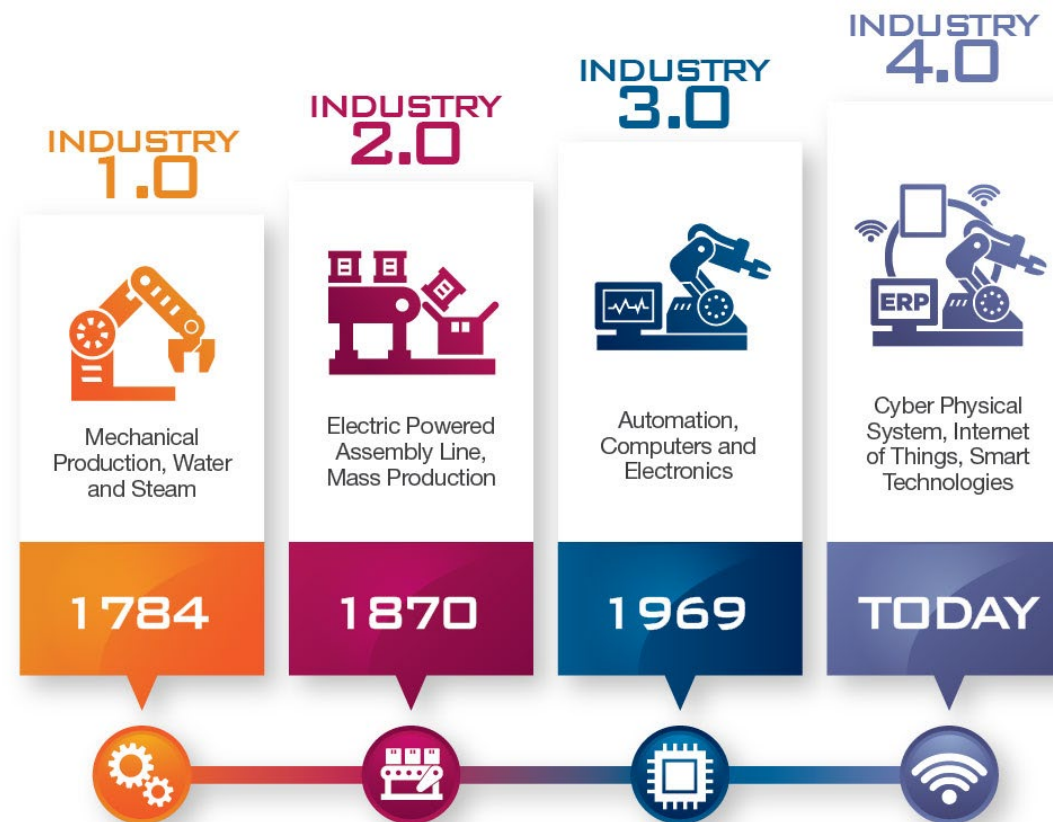
Hecla Field Cabinet



GREENS CREEK AUTOMATION

FUTURE OF AUTOMATION AT GC

- Hecla will continue to look for different ways to bring technology into the workplace to improve both safety and production at the mine sites. We have seen the benefits of automation and its potential and will keep working towards the future of the mining industry as technology continues to advance and the challenges encountered are addressed.



THANK YOU!

Please feel free to contact me with any questions

