INNOVATIONS IN
ROOM AND PILLAR SAFETY

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Summary

- Current Simulation solutions do not address every mining challenges.
- The IM360 has been designed to meet many of these challenges.
- Real World challenges addressed through simulation Innovation.
- Developments now in progress to extend the technology.
• The dominant design pattern of simulation for the mining industry has evolved over the past decade to differing fidelities of:
  – Display Systems (e.g. Flat Panel Arrays, 360° Caves, and Curved Screens);
  – Haptic Systems (e.g. no feedback, vibration, and motion platforms); and
  – Input Systems (e.g. simplified or replicated cabin controls).

• Different combinations of these components have been marketed to address specific market needs, both functional and economic.

• This design pattern is well established within other markets, as most military, aviation and mining equipment is operated from a machine mounted cabin.

• This design pattern allows for the effective monitoring of machine operator behaviors and performance, using the input system as the primary Human Machine Interface (HMI).

• For example, operator controls input can be compared against best practice or standard operating procedure; for an objective assessment of competence or performance.
In 1980’s MSHA mandated the use of line of sight remote controls for continuous miners (CM); to prevent operators being buried in the face, and reduce exposure to dust and vibration.

The use of the CM in a room and pillar operation created a new problem; the operator could pin themselves between the machine, and the rib if not standing in a safe location.

Since 1984 38 Fatalities involving the Continuous Miner:
- All of the fatal accidents involved a remote controlled CM machine.
- Tramming the machine to a new location was the most dangerous work function
- The machine operator was most at risk.
- Of the six fatalities involving the cutter head, three occurred while performing maintenance and three while tramming.

MSHA is now seeking to mandate proximity detection systems for all CM’s, warning the operator and disabling the CM when the operator stands too close.

Therefore, for an effective operator training simulation to be performed, the HMI had to permit the operator to move naturally within the simulated environment during tramming operations.
Underground Comms Challenges

- Communications between entities within a mining environment is essential for team coordination and safety.
- Historically, communications between different entities within simulation has occurred via radio communication on the cabin controls.
- Due to the noisy conditions underground, the most common communication method is a series of cap lamp signals.
- To reinforce the muscle memory (tactile learning) of gesturing during operations and emergencies, natural gesturing is superior to compromises such as command buttons on a controller.
- However to ensure that training is objective and free of bias, assessment of the correct gesture must be made by the simulation, not the trainer.
- *Therefore, for an effective operator training simulation to be performed, the HMI had to permit the operator to communicate via gestures within the simulated environment.*
1. The field tested UG360B underground hard rock platform was used as a starting point, providing:
   - A 360° display system essential for safely monitoring an underground environment;
   - A electromechanical motion platform to provided haptic feedback for seated equipment (e.g. shuttle cars); and
   - Environmental systems such as IP54 rated seals and dual HVAC units to protect equipment and occupants from the environment.

2. To permit for shuttle car (i.e. seated) and continuous mining (i.e. walking) simulation from the same platform, the motion platform was upgraded to be removable.

3. For tracking of operator movement and gestures, motion capture cameras were mounted.

4. Special motion capture markers were designed to attach to standard mining helmets and clothing, permitting training in high visibility clothing, and in the operator’s own hard hat.

5. Wireless remotes for popular continuous miners were produced, to completely untether the operator.

Technologies are collectively referred to as RealMove™.
IM360B—Continuous Miner
INDUSTRIAL PROBLEMS
Cause of Problem:

- Continuous Miner operators can position themselves in risky locations, between the Continuous Miner and the rib, to achieve better visibility and production.
- Proximity detection systems are being rolled out, but there is little training on how to operate a continuous miner when a proximity system is in place.
- There is no understanding of the side effects of proximity detection (e.g. overrides and lost production).

Affects:

- Safety, Productivity

Problem Impact:

- Seeking higher production, operators may inadvertently stray into high risk areas, risking a fatality.
- Continuous Miner operators may significantly decrease productivity due to accidentally shutting down the machine, when proximity detection is installed. Alternatively, they may find loopholes, and operate less safely (e.g. leave cutting head running).

### Key Description

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<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>X</td>
<td>General Location of Fatality</td>
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<tr>
<td></td>
<td>Occurred during maintenance.</td>
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<tr>
<td></td>
<td>Victim not operating machine.</td>
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<tr>
<td></td>
<td>Victim operating machine.</td>
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Sustainable Production

Cause of Problem:

• Continuous Miner and Roadheader operators must achieve the maximum possible production distance to ensure production levels, or to prepare for the next longwall move.

• However, Continuous Miner and Roadheader operators are prone to deviating from plan, or leaving poor top and bottom for the next shift, in order to achieve production.

• Both production, and horizon control must be enforced to ensure sustainable production from the mine.

Affects:

• Productivity

Problem Impact:

• Seeking higher production, operators can leave a mess for the next shift, decreasing overall production.

• If production is significantly behind, revenue is down. If it delays a longwall move, production is significantly impacted.
Productivity Assessment
Cause of Problem:

- Cable damage is a common, and entirely preventable cause of production losses.

Affects:

- Productivity

Problem Impact:

- The average price of Illinois Basin Coal for Aug-2014 was $44.00 per short ton.
- The average cable damage shuts down a section for 1 hour.
- Each minute of lost production is approximately 4.4 tons.
- On average, each damaged cable is costing the industry 4.4 tons x 60 minutes x $44.00 = $11,616.
Cause of Problem:

- Emergency situations by their nature occur rarely, limiting opportunities to practice response.
- A theoretical knowledge of emergency response is not sufficient when making life or death decisions.

Affects:

- Safety

Problem Impact:

- When emergencies occur, an issue can quickly escalate from an issue, to a disaster.
Emergencies
IM360B – Shuttle Car

Shuttle Car Demonstration
FUTURE DEVELOPMENT
MINING FOOTPRINT

- **355+ Deployed Simulators**
- **1635+ Trainers Certified**
- **255+ Global Mining Customers**
- **858+ Deployed Simulator Modules**
- **100,000+ Mining Equipment Operators Trained**
- **14 Global Offices**
- **36 Countries**

REAL RESULTS

**Average Improvements**

- ▼ **14.2% Spot Time**
- ▼ **62.2% Brake Abuse**
- ▲ **10.4% Tire Life**
- ▼ **69.8% Abusive Shifting**
- ▼ **54.5% Engine Over Speed**
- ▲ **6.85% Fuel Use**

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