Eliminating Barriers for the Implementation of Automation in the Mining Industry

NIOSH Automation Partnership
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Focus Area: Regulatory Review for Automation

- Technology Ratcheting Regulations
  - Increase Productivity
  - Reduce Costs
  - **Improve Safety & Occupational Health**
  - Achieve Quality Gains
  - Shareholder Expectations
  - ESG Goals

Regulatory Review for Automation

- Incentives are eroded by regulatory barriers
- Disincentives impair the implementation of automation and new technologies
- Regulations are mandated to ensure the highest level of compliance
- Regulations could not have foreseen the rapid development of technical advances

Regulatory Review for Automation
Our assumption

Prescriptive regulatory system under which US mines operate provides little motivation and creates barriers to implement new technologies and highly automated systems

Alignment with the SME

Vision

We build a better world through mining, metallurgy and underground construction

Mission

We build a better world through mining, metallurgy and underground construction

Core Values

- Safety
- Stewardship
- Innovation
- Ethics
- Inclusion
- Collaboration

Objectives

Objective One

- Identify and evaluate current U.S. federal regulations that may serve as a barrier to implementation of mine automation with potential to improve mine safety and health, as well as identify other technical areas preventing or slowing the progress of automation.

Objective Two

- Identify regulatory strategies that have been successfully adapted in other industry jurisdictions and countries that encourage implementation of mine automation and other new technologies to improve mine safety and health including the economics, permitting and other technical matters.

Objective Three

- Describe potential avenues for the successful implementation of mine automation in the U.S., including research required to demonstrate that an equal or higher standard of mine safety and health may be met.

Scope of Work

- Review Current State of Technology
  - Automation
  - Equipment Autonomy
  - Sensors
  - Artificial Intelligence
  - Communication/Data Transmission Systems

Phases of Work

Task One: Review of regulation, and changes in regulations that have encouraged mine automation in other countries

Task Two: Identification of stakeholders and organization of workshops

- Stakeholders advancing and using automation
- Technical groups who understand barriers

Task Three: Workshops and Data Collection

- Include Stakeholders who have expertise and knowledge
- Six Workshops in various parts of the US
- Small focus groups convened as necessary

Task Four: Development of Deliverables

- A final report will be completed by December 31, 2024

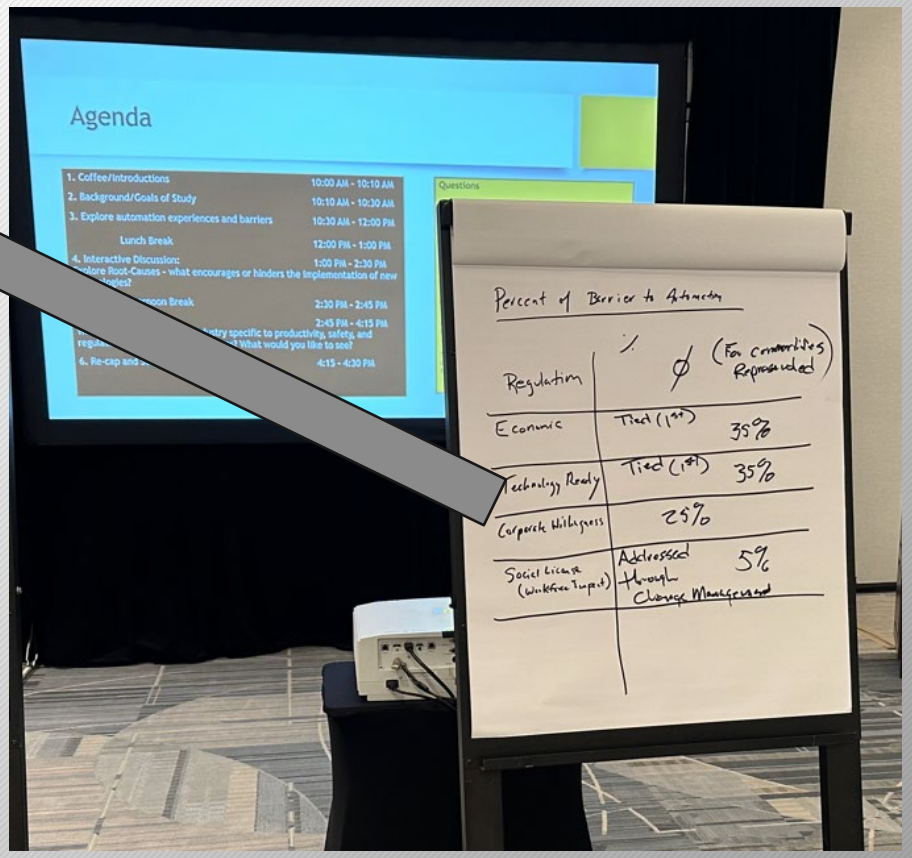
Workshops

Location	Conference	Attendees
Tucson, AZ	SME Arizona Conference	21
Denver, CO	MINEXCHANGE 2023 SME Annual Conference	17
Virginia, MN	SME Minnesota Conference	15
Boston, MA	Rapid Excavation and Tunneling Conference	16
Phoenix, AZ	Hydrometallurgy 2023	24
Canonsburg, PA	SME PCMIA Conference	17
Nashville, TN	NSSGA Conference	12
Triadelphia, WV	MSHA ACC	14
Elko, NV	Elko Mining Expo	10
		146

General Workshop Organization

- Themed expertise
- 10-20 participants
- Introductions
- Broad Discussion
- Focused discussion → area of expertise
- Breakout groups with set questions
  - Motivation for automation
  - Company practice in research and capital projects
  - Barriers/Drivers

Regulations
Economics
Technology Readiness
Corporate Willingness
Social License



Workshop held jointly with

SME Arizona Conference | Tucson, AZ

December 2022

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- Major Copper Operators and OEM
- *Need for a collaborative relationship between industry and regulators (e.g., the EMSR [Earth Moving Safety Roundtable] in AUS)*
- *Small operators need the most assistance from NIOSH and MSHA*
- *The brownfield nature of the bulk of the U.S. operations has made implementation more difficult.*
- *Current drivers in the U.S. are lack of workforce and low carbon tech.*

Barrier	Percentage
Regulation	5%
Economics	**55%**
Social License	10%
Corporate Willingness	15%
Technology Readiness	15%

Workshop held jointly with

MINEXCHANGE 2023| Denver, CO

February 2023

2

- Very diverse group – multiple commodities, OEM
- *Exposure based regulation is driving autonomy in some cases.*
- *Discussion of workforce – automation will change the workforce but not reduce it in the short term*
- *Level 7 automation is currently attainable (system runs in an automated mode with monitoring and opportunity for operator intervention, but Levels 7-9 (fully autonomous) is difficult legally and operationally*

Barrier	Percentage
Regulation	25%
Economics	**40%**
Social License	5%
Corporate Willingness	5%
Technology Readiness	25%

"The problem is not a specific regulation but the specificity of regulation"

-Workshop attendee

Workshop held jointly with

SME Minnesota Conference| Virginia, MN

April 2023

3

- Iron range and aggregate operators
- *The workshop was an outlier in terms of workforce. Strong union in the region and a strong workforce. Operators are not as concerned about lack of workforce in this workshop, but they are concerned about alienating the community with automation.*
- *Capital budgets are fairly small for automation at the is time.*
- *Phased process is key → collision avoidance is high priority*
- *There was some discussion re: automation and the control an OEM has over the business.*

Barrier	Percentage
Regulation	25%
Economics	**50%**
Social License	5%
Corporate Willingness	10%
Technology Readiness	10%

Workshop held jointly with

Rapid Excavation and Tunneling Conference | Boston, MA

June 2023

- Tunneling and construction professionals
- *Labor shortage is a driver (COVID changed perspective).*
- *Dust and environmental exposure are key areas for automation.*
- *Iterative barriers exist.*
- *Gaps between US uptake and others:*
  - *Liability*
  - *Zero Harm Mentality (as opposed to acceptable risk)*
  - *Compliance vs. Risk regulatory perspective*

Barrier	Percentage
Regulation	15%
Economics	35%
Social License	5%
Corporate Willingness	20%
Technology Readiness	25%

Workshop held jointly with

Hydrometallurgy 2023 | Phoenix, AZ

August 2023

- Processing plant operators, vendors, and OEM
- *Fixed plant nature has allowed for early and long time adoption of automation.*
- *Still and need to mimic the highly experienced and skilled metallurgist with sensing and data science.*
- *Maintenance is also a difficult area to automate.*
- *Many OEMs working in one plant – connectivity and data access are issues. One operator just had a major IT security breach so this may become more of an issue. Standardization would be helpful.*

Barrier	Percentage
Regulation	3%
Economics	**35%**
Social License	15%
Corporate Willingness	15%
Technology Readiness	32%

Workshop held jointly with

SME PCMIA Conference | Cannonsburg, PA

October 2023

- Coal operators and OEM
- *There is consistency in new technology across a single company's mines. The workforce is now more mobile (between shifts and operations) allows technological innovation and safety innovation to move more rapidly.*
- *R&D departments are not as robust in the industry and individual companies as they once were, and many simply do not have R&D departments or budgets.*
- *Coal industry will always share safety ideas within the industry, including new technology – there are no secrets in safety. That is a source of pride in the industry.*
- *There was sentiment that there is no appetite in federal government to incentivize new technology in coal, because there is generally not an appreciation for the need to mine coal in the U.S.*
- *Permissibility and MSHA approval are seen as a barrier.*
- *Workforce shortages are felt to be even more magnified in coal.*

Barrier	Percentage
Regulation	33%
Economics	**35%**
Social License	17%
Corporate Willingness	10%
Technology Readiness	5%

Workshop held jointly with

NSSGA Conference | Nashville, Tn

March 2024

- **Stone, sand, and gravel operators and OEM**
- Given that most aggregate operations have traditionally been family owned and operated and are locally significant in terms of employment and economic impact, social and community engagement are important considerations when making changes.
- Data ownership and security was key – the consensus being “the machine owner owns the data”
- Scarcity of skilled labor is driving automation
- Careful integration of technology with the workforce is vital.

Barrier	Percentage
Regulation	10%
Economics	**40%**
Social License	28%
Corporate Willingness	16%
Technology Readiness	6%

Workshop held jointly with

MSHA Approval & Certification Center | Triadelphia, WV

March 2024

- Labor representatives, coal operators, MSHA ACC
- Two barriers were identified for coal (versus m/nm). A) small market stifles innovation, and B) the dynamic nature of the coal mine face also makes automation more difficult (as compared to a block cave, for instance).
- Technology ratcheting regulation (e.g., communication and tracking, proximity detection, potentially the new silica regulation) versus other regulation. It can be difficult to point to regulation as a barrier it has the capacity to "chill" innovation.
- Labor is supportive of technology that improves safety including automation
- MSHA, like all sectors of the industry, is very concerned about workforce. Additionally, it is difficult to maintain the ACC and mine rescue equipment in light of rapid technology innovation.

Barrier	Percentage
Regulation	20%
Economics	20%
Social License	20%
Corporate Willingness	20%
Technology Readiness	20%

Workshop held jointly with

Elko Mining Expo | Elko, NV

March 2024

- Major gold operators
- Risk tolerance of the operator must increase with greater reliance on automation/autonomy.
- Systems must be properly designed for the specific mine environment. OEMs are not always competent or interested in the specific factors influencing a particular operation
- The availability of skilled labor is important and needs to be considered. Labor cost savings shouldn't be part of the assessment, but availability is huge, particularly in some remote areas. Many companies are near-sighted with respect to labor costs, and don't understand the importance of upgrading labor skill sets with automation despite the increase in costs. Can be disastrous for an operation.
- Mines (competitors) will collaborate on technology to diminish risk or to address regulatory issues (the use of autonomous haul trucks and DPM).

Barrier	Percentage
Regulation	**25%**
Economics	20%
Social License	20%
Corporate Willingness	30%
Technology Readiness	5%

Regulatory Review

- A comprehensive review of all MSHA Regulations
  - Preliminary Report Filed
  - List Compiled

  - 100 Separate regulations identified as potential barriers
  - Statutory Framework in which the regulations reside presents a barrier to regulatory evolution for automated equipment

- MSHA regulations are broadly segregated by industry sector
- 30 C.F.R. Parts 56 and 57 regulate surface and underground metal and non-metal mines

Regulatory Review

- Addressed four general types of potential barriers to automation:
  1. Does regulation require a “person” to conduct a certain activity
  2. Does the regulation require that equipment be “attended” or operated by a person?
  3. Does the regulation require features (such as a seat belt) be installed in equipment that would not be necessary for safety if no human was operating it?
  4. Other regulations that could potentially create a barrier to automation but do not easily fit into another category

Regulatory Review and Analysis

- **85** Separate regulations that deal with extraction and are identified as presenting some barrier to automation or innovation
  - **60** require a person
  - **6** required attended equipment
  - **9** required installation of features for people
- The approval apparatus is cumbersome
- There is acknowledgement that MSHA attempts to interpret regulation in a way that does not stifle innovation.

Example of Regulatory findings

"30 C.F.R. Part 22, which governs approval of portable methane detectors essentially states that a portable methane monitor will be approved if it meets the requirements of Bureau of Mines Schedule 8c, which went into effect October 31, 1935 and was amended by a supplement issued in April, 1955. While detector technology may or may not have changed significantly in the last 68 years, it is likely that the way in which the levels detected are communicated to and interact with mine equipment and personnel have changed significantly during that period."

Final thoughts

- Regulation is not the barrier to automation in the U.S.
- The issue is complex and commodity specific, but workforce challenges across commodities are likely to drive automation AND drive additional training needs.
- There is recognition that an industry-led group needs to look at standards and technology integration with regulation, and that regulator-operator collaboration is key.
- The workshop model (especially one that takes regional and commodity context into account) is an excellent tool for collecting ideas and information.
- U.S. regulation is highly prescriptive, and while not all sectors recognize it as a high barrier, it is likely a high barrier for underground coal AND regional differences in enforcement and interpretation are a concern.
- There is opportunity for NIOSH to consider the role of health and safety research in the other identified barriers.

Thank you

- Questions and Comments