

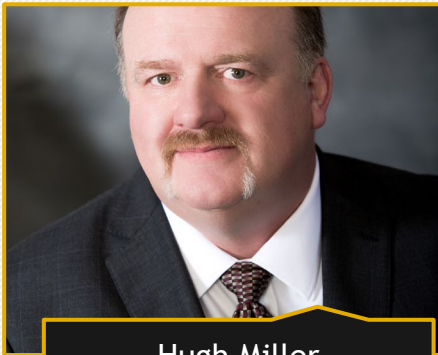
Eliminating Barriers for the Implementation of Automation in the Mining Industry



NIOSH Automation Partnership
September 21, 2023
CDC/NIOSH Contract 75D30122C14149

*Kray Luxbacher, PE, PhD
Department Head and Gregory H. and Lisa S. Boyce Leadership Chair
Mining and Geological Engineering
University of Arizona*

Collaborators and Contacts



Hugh Miller
hbmiller@mines.edu



Kray Luxbacher
kraylux@arizona.edu



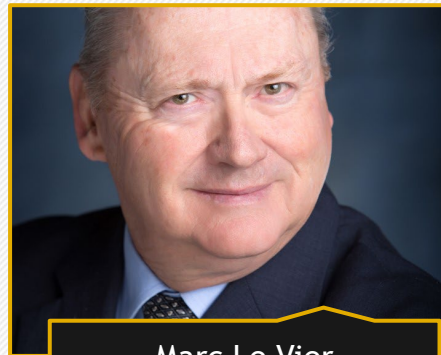
Michael Moats
moatsm@mst.edu



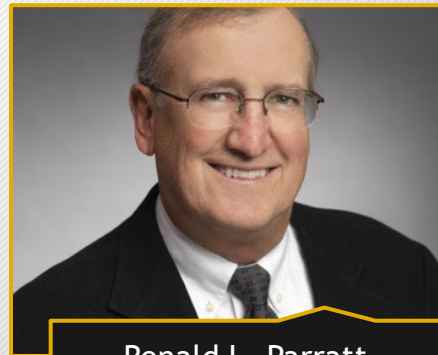
Mark Savit
msavit@predictivecompliance.com



Ben Miller
ben@Lewicki.biz



Marc Le Vier
Marc.levier@comcast.net



Ronald L. Parratt
RONPARRATT@AOL.COM



David L. Kanagy
kanagy@SMEnet.org

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 that 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

- Prescriptive regulatory system under which US mines operate provide little motivation and create barriers to implement new technologies and highly automated systems



SME's Focus

- Mining
- Mineral Processing
- Exploration
- Expanded Work to Include:
 - Health & Safety
 - Technical Issues



SME's Focus

- Automation provides opportunities to isolate workers from potential hazards, adverse health exposure, and risk



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

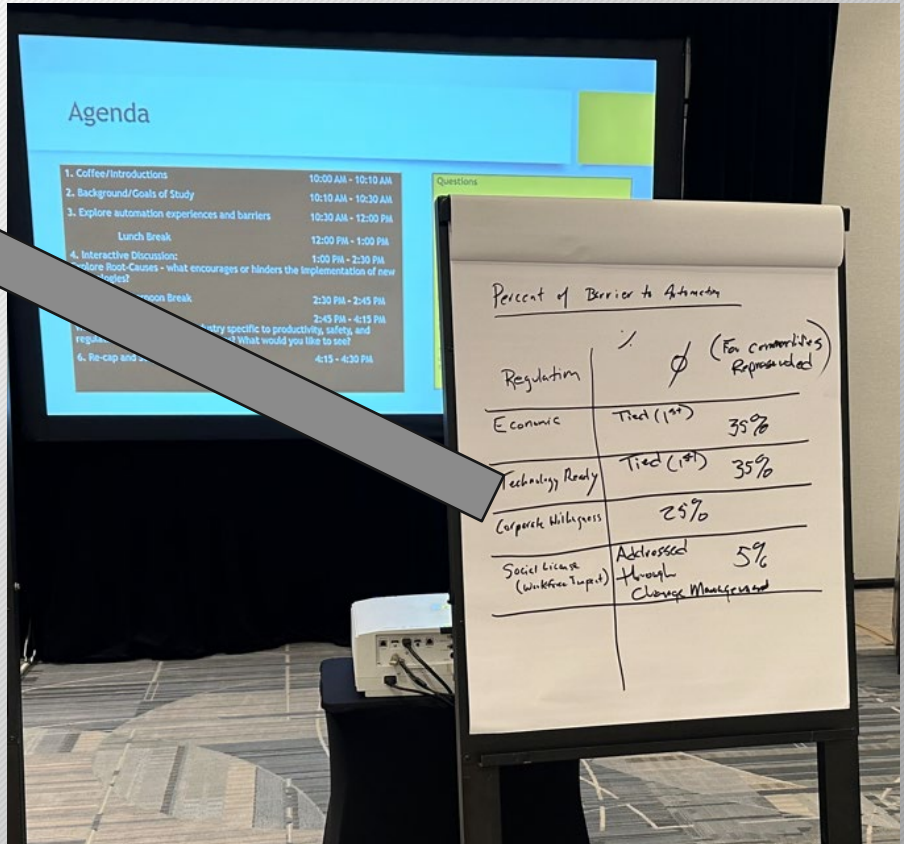
Task Four: Development of Deliverables

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

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



Workshops

SME MN
Virginia, Minnesota
April 2023
Iron Range Operators

SME Annual Meeting
Denver, Colorado
February 2023
Diverse Group

+2
TBD

Rapid Excavation and Tunnelling
Boston, Massachusetts
June 2023
Tunnelling Construction Professionals

Hydrometallurgy
Phoenix, Arizona
August 2023
Processing & Plant Automation

SME /PCMIA
Canonsburg, Pennsylvania
October 2023
Coal Operators

SME AZ
Tucson, Arizona
December 2022
Major Copper Operators

Every group has included relevant OEM and consultants

Workshop #1 - Tucson, AZ

Major Copper Operators and OEM

- *Need for a collaborative relationship between industry and regulators*
- *Something like 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
Regulation
Economics
Social License
Corporate Willingness
Technology Readiness

Successful Tech
Drones
Fatigue Monitoring
Fleet Management
Drons
INSAR
RADAR/LIDAR
Dynamic ERP (Enterprise Resource Planning)
Electronic blasting delay
Automated guarding (belts)

Workshop #2 - Denver, CO

Diverse group, UG, surface, OEM

“The problem is not a specific regulation but the specificity of regulation”

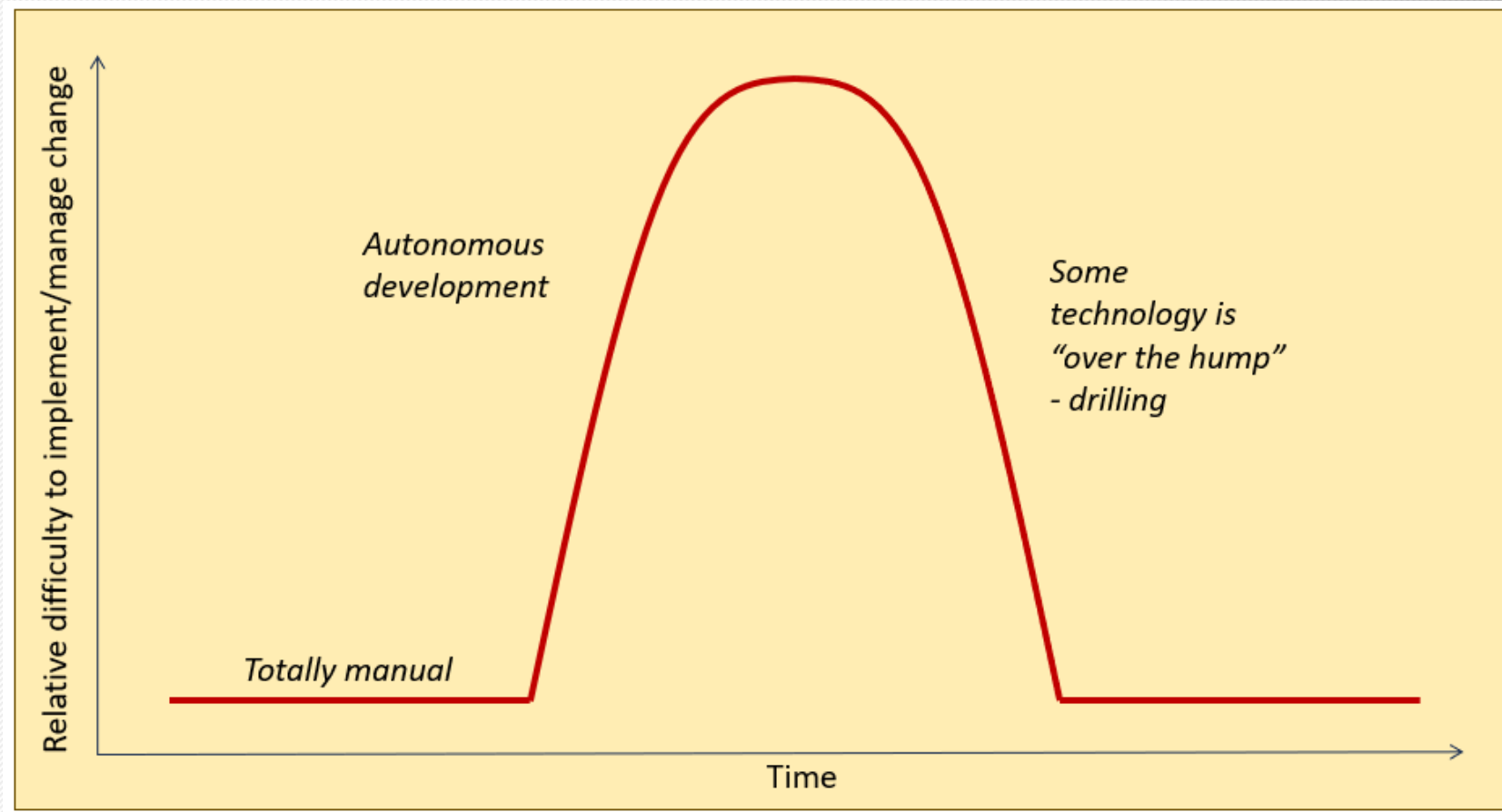
-Workshop attendee

- 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%

Workshop #2 - Denver, CO

Diverse group, UG, surface, OEM



Workshop #3 - Virginia, MN

Iron Range 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	10%
Economics	50%
Social License	5%
Corporate Willingness	20%
Technology Readiness	15%

Workshop #4 - Boston, MA

Construction/Tunnelling

- Labor shortage is a driver (COVID changed perspective)
- Dust and environmental exposure
- 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	10%
Corporate Willingness	20%
Technology Readiness	20%

Workshop #5 - Phoenix, AZ

Preparation and Processing, 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	32%
Corporate Willingness	15%
Technology Readiness	15%

Preliminary Findings

- Barriers to automation vary considerably by industry sector.
- There is substantial concern around system standardization and implementation, which is may present an opportunity.
- 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.

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

Thank you

- Questions and Comments