University of Pittsburgh

University of Pittsburgh
Department of Industrial Engineering – University of Queensland – NIOSH Funded

A Global Perspective on Automation Experience in Mining – An Assessment of the Automation Impact on Worker Safety and Health

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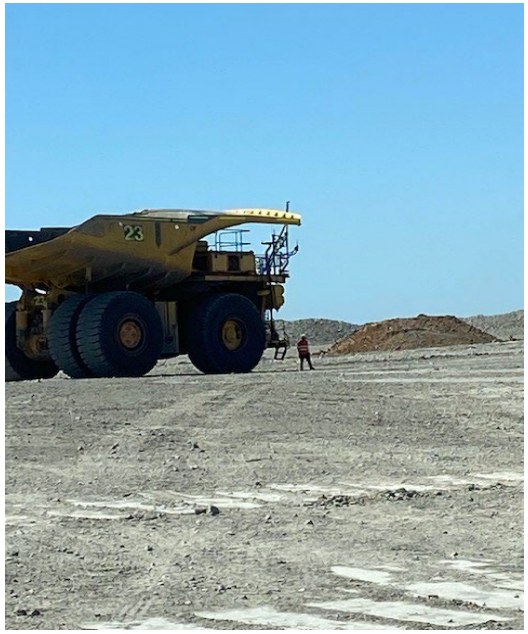
Pitt – UQ – NIOSH research: Automation in Mining Background

- Technology development moving at a rapid pace
- Mining industry must improve productivity to stay in business
- US Mining is behind other advanced countries in the implementation of automated systems



Pitt – UQ – NIOSH research: Automation in Mining Background

- NIOSH is concerned about health and safety of the worker during the transition to more automated systems
- Commissioned and funded this study to explore how advanced countries are implementing automated systems in mining
- NIOSH is interested in a Global Perspective

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- Research Grant – (3 years – started in 2020)
  - Completed research to inform NIOSH future research
  - University of Pittsburgh subcontracted with University of Queensland
  - COVID complications – international travel had to be delayed by nearly two years
  - Recruited mines with advanced automation transition.

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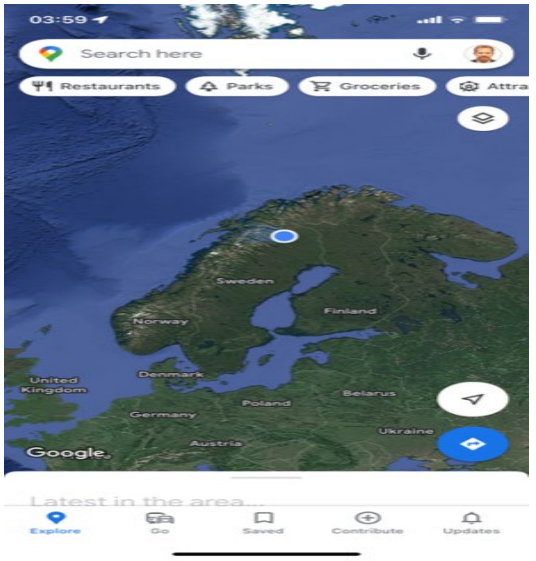
- Methodology
  - Convenience sampling – recruit as many companies in as many advanced mining countries as possible
  - Convenience sampling – interviews and structured interviews (13 basic questions) with workers as available
  - Convenience sampling – observations of operations



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- Coal mines - underground and surface (Australia)
- Iron ore mines – underground (Sweden and Brazil)
- Copper ore mines – surface (Chile)
- Gold and platinum mines – Underground (South Africa)
- Diamond mines – Underground (Botswana)
- Gold, Silver, Lead and Zinc – Underground (US Alaska)
- Oil sands – (Canada – *did not visit, but interviewed*)

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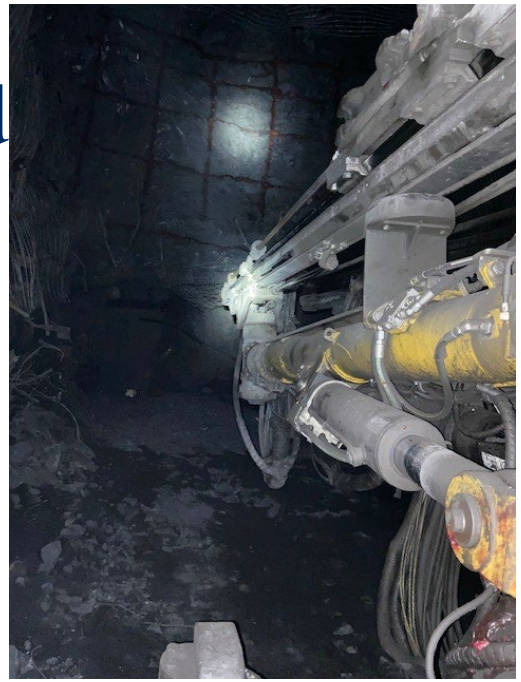
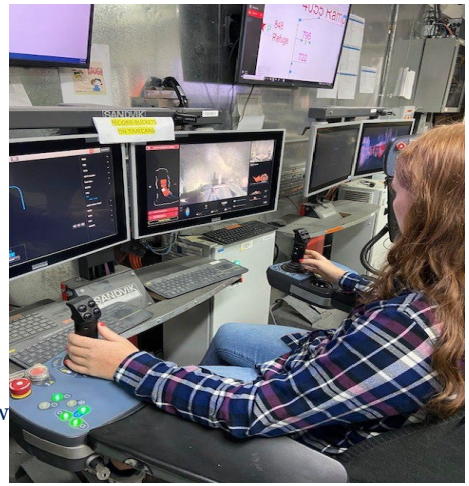
- Mining equipment being automated
  - Automated haulage (Trucks and Train)
  - Automated loading operations
  - Automated drilling for blasting
  - Automated mineral processing operations
  - Introduction of robots





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First Grant Component

- NIOSH Automation and Emerging Technologies Partnership
  - Nearly 300 members
  - Industry, equipment manufacturers, labor, government enforcement and researchers, consensus organizations, academics, etc.
  - International membership (Canada, Australia, Sweden, Chile, US)

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- NIOSH Automation and Emerging Technologies Partnership
  - Foster collaboration to promote and identify health and safety research needs to inform future research and funding needs
  - Annual meeting (10/Oct - 4th annual)
  - LinkedIn work group

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- NIOSH Automation and Emerging Technologies Partnership
  - Partnership
    - CDC - Mining - Automation and Emerging Technologies Partnership – NIOSH
  - Linked in Group
    - https://nam12.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.linkedin.com%2Fgroups%2F9120356&data=05%7C01%7Cjhaight%40pitt.edu%7C536d0a1cba74482c9fda08da52ef1777%7C9ef9f489e0a04eeb87cc3a526112fd0d%7C1%7C0%7C637913484082296016%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C3000%7C%7C%7C&sdata=DiimSGQVujaI9O3nL83I7cgWXINODOb8TLIJucOtdfA%3D&reserved=0

Pitt – UQ – NIOSH research: Automation in Mining – the questions we asked

- Are workers safe in the mining industry?
- Does automation make employees safer?
- Is productivity improved?
- How does/should a company transition from manual to automated operations?
- Will people lose their jobs?

Longwall coal mining - Australia

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- Concerns of the Partnership and NIOSH – Themes
  - Human Machine Interface
  - Interoperability – distributed situational awareness
  - Worker Skill Gap – willingness and sustainability
  - Cyber Security – Automation data in the c loud is accessible
  - Regulatory limitations and response –prescriptive approach?
  - Standards and Guidelines

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To address Partnership concerns

1. Incidents at the interface
2. Automation Decision Process
3. Standards and guidelines – standardization, terminology
4. Manufacturer/Union/Regulator/ Industry perspectives and objectives
5. Health and Safety Research needs (risk, job loss/training impact, Worker Transition and Skill Gap, etc.)
6. Industry Concerns (inter-operability, cyber security, etc.)

Pitt – UQ – NIOSH research: Automation in Mining Findings

1. Incidents

- Few incidents – Reductions noted, but anecdotal
- 91,000 incidents (injuries) in US mining industry between 2010 and 2020 and only 76 contained the term automation (none were automation caused)
- Western Australia (83 incidents over 5 years) and all were interoperability or terrain related – no injuries

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2. Automation Decision Process

- Wide range of approaches from "Look at an entire operation and ask, what do we automate?" Steel processing?
- Risk Assessments – (Australian study funded by ACARP – a mix of risk assessment techniques should be employed) – Australian companies currently conducting these risk assessments (UQ and Pitt study)

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2. Automation Decision Process

- **Australia** – productivity driven, risk-based decision making – get workers out of harsh environments – move to livable cities to control centers
- **Swedish** mining companies driven by productivity determination and the need to get workers into a more comfortable environment…..workers provide input
- **US and South African** industries doing smaller scale pilot case studies
- **Chile** – Copper mining automated haulage and drilling – elevate workers to higher thinking jobs, allow them to operate the mine from livable cities, more mining jobs have become attractive to women

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3. Standards and guidelines

- ISO standards (contribution from AEM of the NIOSH Partnership)
  - ISO/TC 83/SC 8 Advanced Automated Mining Systems
  - ISO 73.100 Mining Equipment
  - ISO 19296.2018 (en) Mining - Mobile Machines Working Underground
  - ISO 17757:2017 Earth-moving Machinery and Mining – Autonomous Machine System Safety

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3. Standards and guidelines

- Global Mining Guidelines Group (GMG Group) developing guidelines
  - Guideline for Sharing Open Data Sets in Mining
  - Guideline for Applying Functional Safety to Autonomous Systems in Mining
  - Guideline for Implementation of Autonomous Systems in Mining
  - Mobile Equipment Open Data Consensus Guideline

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4. Manufacturer/Union/Regulator/ Industry perspectives and objectives

- Manufacturer is concerned about functionality
- Union is concerned with worker outcomes (skill gap, job loss, health and safety, etc.)
- Regulator is concerned about the safety impact of new and relatively untested equipment entering a mine site.
- Industry is concerned about productivity and worker comfort and safety – but also skill availability

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5. Health and Safety Research needs (Risk, Job Loss/Training impact, Worker Transition and Skill Gap, etc.)

- Adequate risk assessments completed in decision making?
- Job loss? Swedish, Chilean and Australian companies say in last 20 years, no one has lost their job to automation
- Jobs now demand higher order thinking (automation paradox – Lisane Bainbridge)
- One Swedish miner said “back in the day, we used to be just miners, now we are miners, programmers, equipment technicians” “We don’t want to go back!”

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5. Health and Safety Research needs (risk, job loss/training impact, Worker Transition and Skill Gap, etc.)

- Older workers retire, middle career workers seem to embrace the challenge and younger workers, that is all they know (acceptance of technology has an age effect).
- There are transitional difficulties (e.g. interoperability) as experienced in Australian surface mines – manual operations get tangled with automated operations and everything has to shut down to sort out – costly
- Swedish, Chilean, Australian and South African miners say that they have not experienced any automation-caused injuries

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5. **Health and Safety Research needs (risk, job loss/training impact, Worker Transition and Skill Gap, etc.)**

- As mines get deeper, they are not habitable by humans
- Currently, not all operations are automated and so some human workers are still required in the mine, for example maintenance and other technicians changing out worn equipment (drilling operations and long wall operations)
- In deep mines, much of the shift is taken up in just traveling to and from the working face
- Many operations in Sweden and Australia are remotely operated and as such, keep mine operators engaged

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6. Industry Concerns and Findings

- Worker Skill Gap – availability and sustainability
- Interoperability – Distributed situational awareness
- Cyber Security – automate and your data can become accessible
- Regulatory response to technology development (Australia, Sweden and Chile – all do risk-based decision making, but US is driven by regulators that are prescriptive.)

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6. Industry Concerns and Findings

- Barriers do not seem to be regulatory, but cultural and financial
- Pitt and UQ Research
  - US still focused on productivity
  - Australia, Sweden and Chilean companies after 15 – 20 years struggle to show productivity gains.
  - Loaders – 40 tons vs 25 tons (decreased maintenance costs), haul truck tires 4000 hours vs 10,000 hours
  - Loaders operate immediately after blast – gain four hours of operation over manual

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6. Industry Concerns and Findings

- US slowed due to high cost systems that require years to implement with little to no apparent benefit for years.
- Short mine life problems with many mines
- Smaller mine sizes in US
- Technology barriers (Alaska mobility- spiral design) and cultural readiness (Australian Coal – age-related resistance)

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- Are workers safe in the mining industry? Mining is considered a dangerous industry underground and surface. Struck by hazards, noise, dust and other respiratory hazards, illumination, heavy equipment risks.
- Does automation make employees safer?
- Removes worker from the hazard, the operating environment is more comfortable and healthy, but maintenance is still an issue.
- Is productivity improved?
- Haul truck tires 4000 hours if manual operation, but 10,000 hours if automated, underground loader maintenance reduced with steady operation, automated loaders can operate immediately after a blast

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- How does/should a company transition from manual to automated operations?
- Ensure the operators and maintenance people are involved in all stages of the transition, extensive training in a higher order role….programming, oversight of larger operation.
- Will people lose their jobs?
- In five advanced countries over a 20 year transition period, no one lost their job due to automation (involuntarily). In fact, every company studied hired more people to run the operation.

Pitt-UQ-NIOSH Research Final Thoughts

- Miners' risks of injury and illness is will continue to be lower.
- Productivity goals have not been reached?
- Technology will continue push the industry
- People have not and will not lose jobs (if they accept the integration)
- US will have to find away to implement risk-based-decision making
- MSHA will have to allow more technology in the mines