Robots in Mining

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Outline of presentation

• Hypothesis
• Current mine safety statistics.
• Where is it unsafe?
• What do they do now?
• FOG – Fall of ground
• Who is at risk?
• What is the cost of incident?
• What can we do about it? The Robot Potential
• Technology
• Conclusion
Yes Robots can improve mine safety

Robot patrols
unoccupied areas
Generates a risk map
Additional tool
Inform miners
in making safe
Miner Safety Statistics

- from DME (2010/03)
- March 2010
  - 490 000 employed
  - 400 000 suppliers
  - 9 died, 7 in rockfall incidents
- Prior year - March 2010
  - 152 fatalities (184 previous yr)
  - 0.14 per million hrs worked (0.16)
  - 0.31 per 1000 people at work (0.36)
  - Every 2.5 days a miner dies... In a potentially preventable accident
Annual Fatalities

- Good downward trend
What Kills People?

- South African Mining fatalities
- 2007 = 220 fatalities
Change since 2007?

- Fewer fatalities
- Same ratios, same causes
What is a FOG and why does it happen?

- Statistical certainty unless the roof is supported.
- People are injured because:
  - Standing under unsupported unsafe hanging wall when it fails
  - Wrong place at the wrong time
  - The entry inspection is not done well, or at all
- 1993 examination of all FOG incidents indicated the primary reason was:
  - Inadequate examination, inspection or test
- Everybody's job = Nobody’s job
- There is no generic name for the job of “hanging wall examination”
  - Barring,
  - making safe,
  - early examination,
  - entry examination

1. 1996 MHSC report GAP202
2. 1993 MHSC report GAP055
How is it prevented?

- Early entry examination process
- Taps the roof with hammer, based on what it sounds like
- Determine if it is unstable or not.
- If it is unstable – he can
  - Bar it down with pinch bar
  - Support with temporary support
  - Put in permanent support.
- executed
  - Re-entry into pre-worked area
  - After a passage of time
  - Shift change
  - After blast
  - When needed
What do they do exactly?

- Conventional Mining is cyclic –
  - Drill, charge, blast, clean
- Somebody determines if it is safe to work before miners enter.
- The worst job in the world?
- 50% of rock related fatalities are in the stope
- Before human entry – somebody has to make it safe – responsibility of the shift boss.
- Pinch bar and hammer to detect and remedy unsafe hanging wall conditions
  - based on experience.
  - Everybody waits while it happens
- Stressful job

1. 2001 MHSC report GAP727
2. 1993 MHSC report GAP055
The process

• Who is at risk?
  • Anybody involved in the making safe process
  • Anybody under unsupported ground
• The miner has tools to assist him
  • Pinchbar and hammer
  • Electric Sounding Device (ESD)
  • Thermal imaging
• A robot can be an additional tool
Cost of an incident

- Shaft/section closes for investigation – section 54
- Until all bodies are recovered
- In 2009, Anglogold Ashanti (AGA) SA ops lost 166 shifts,
  - with 98 of those due to Department of Mineral Resources (DMR) safety stoppages, and
  - 68 shifts due to voluntary safety stoppages.
  - During that period, there were 16 fatalities.
  - average cost of \( \text{R3 million/shift} \) in lost revenue
  - this translates to \( \text{half a Billion Rand} \)
  - for a single gold mining company

- The industry cost?
  - 152 deaths
  - associated closures = R?
The Cost of inefficiency

• Mining is cyclic –
  • Drill, charge, blast, clean
• All blasts are co-ordinated in an empty mine
• Any single incomplete part implies a missed blast – and a missed cycle
• Blast ratio: number of blasts/number potential blasts
• Ideal = 100%
• Blast = 1.1m advancement, with 22 working days/month = 24m/month
  • Only 16m/month average
  • implying 66% blast ratio
• 1% improvement in blasts
  • = 1% more ore mined
  • = 1% more gold mined
• Millions to the bottom line
• Implication is a faster inspection
  • = better blast ratio = more profit
The Robots Potential to Assist

- Between blast and re-entry: 3 to 4 hours of unproductive time
  - fumes and seismicity
- Autonomous vehicle could patrol the area
- Generate a risk map of the upcoming shifts
- Akin to a weather map
- Faster making safe
- Indication of unsafe area: less standing in unsafe areas = fewer incidents
Blast Seismicity

- Increased after blast
- Time decay to background levels
- Typical 3 to 4 hours for mine wide blast
Thermography

- Support shown
- “loose” rock apparent on LHS
So Robots can make mining easier

- Thermography to identify threat areas
- Sounding device to delineate boundaries
- Ultrasonic Beacon system for localisation (replacing GPS)
- Creates risk map for mitigating action in the coming shift
In Conclusion

- Robots can assist in making mines safer
- And more efficient
- Pre-examining the stope area prior to human entry
- Providing a risk map indicating where mitigating action is required
- Improving the current making safe process
- Saving approximately R800 million in lost production
- And upwards of 36 people lives
- Under current mining conditions.
- Future with more difficult mining conditions
- Potentially much more to contribute
Thank You