Time, Water and Energy to Clean a Stope Panel using Water Jetting

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Jet Cleaning Model

… the ***art*** of mining is ***cleaning***

- … why is cleaning important?

SLOW cleaning ☐ LOW profitability

- Good news: Cleaning **TIMES** can be reduced

Why create a Jet Cleaning Model?

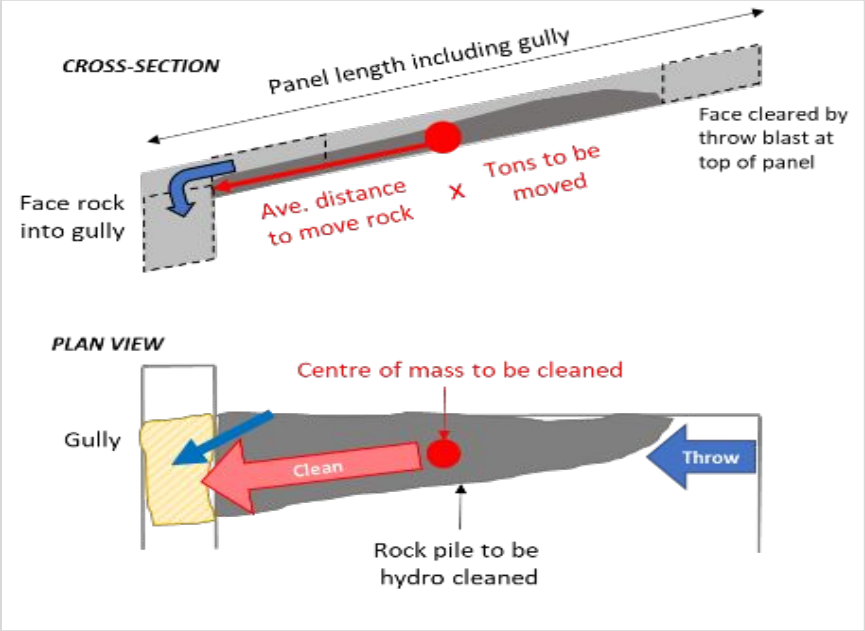
- 40-year old tech … a difficult, practical skill, prone to delays

  - To provide **INSIGHT to key FACTORS**
  - To **HIGHLIGHT ISSUES** to be addressed
  - To **ANSWER QUESTIONS** quantitatively

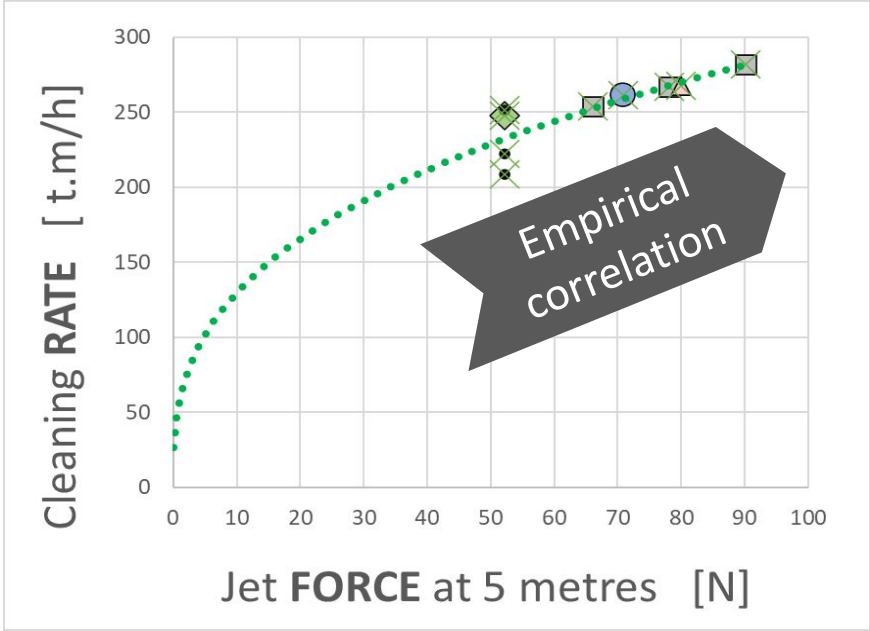
    1. Time to clean a panel?
    2. Optimum panel length?
    3. Most suitable jet cleaning tool?
    4. Production improvement expected?
    5. Water m^3/t?
    6. Energy kWh/t?
    7. Can the dirty water be managed?
    8. Effects on working environment?
    9. Any other issues to be considered?
    10. Safety?

Model "Drivers"

Cleaning **TASK** [ton x metres]



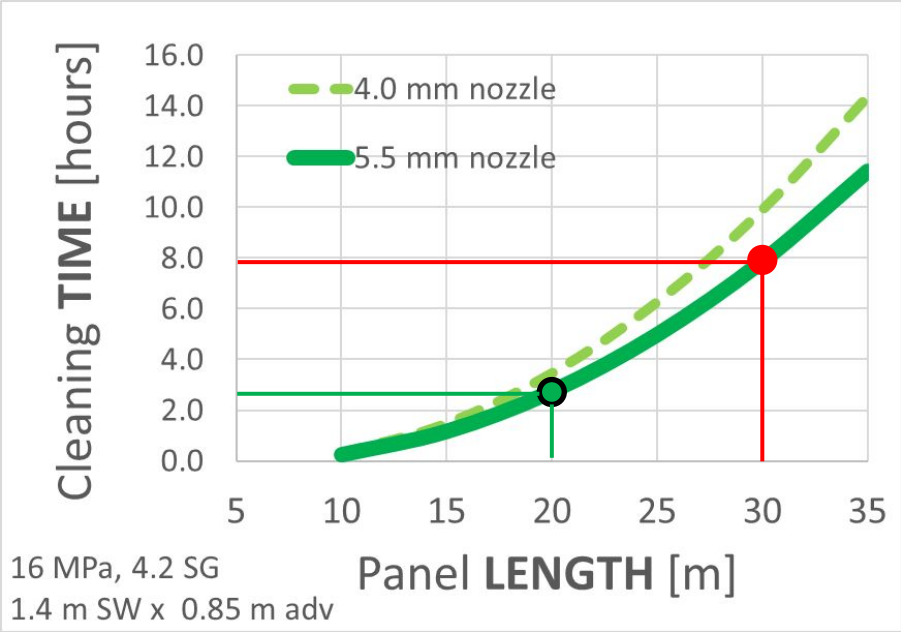
Cleaning **RATE** [ton x metres / hour]



Cleaning **TIME** [h] = $\frac{\text{Cleaning } \mathbf{TASK}}{\text{Cleaning } \mathbf{RATE}}$

Adjust for **DIP** using a factor based on friction theory

Results: Insight #1

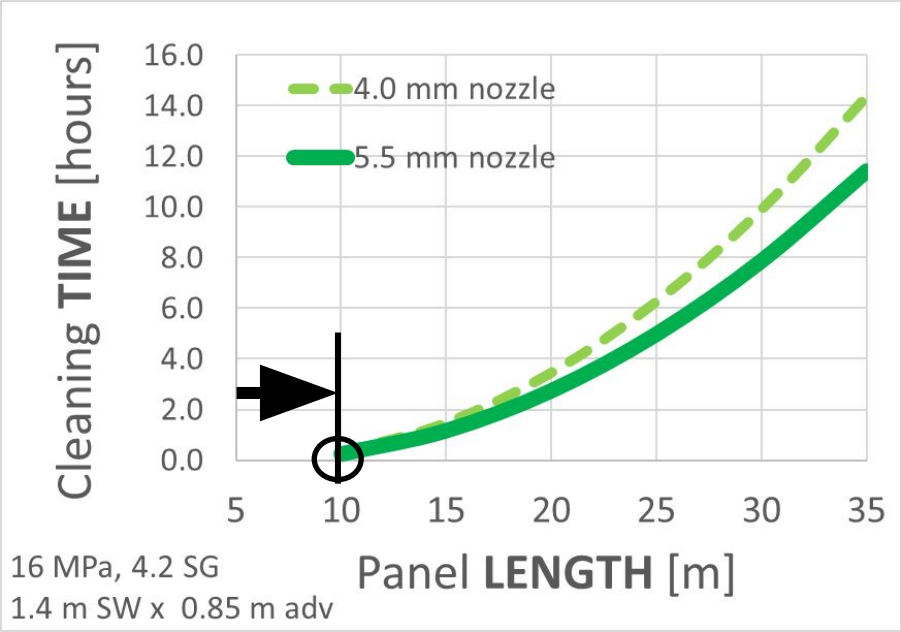


Cleaning **TIME** $\propto$ **(LENGTH)**^{2}

30 m >3x 20 m

- 45 m long panels of 1980s gold mines, in which water jet were intended to assist NOT replace scrapers, is only possible with steep dips, smooth footwalls & face scraper PLUS jets

Results: Insight #2



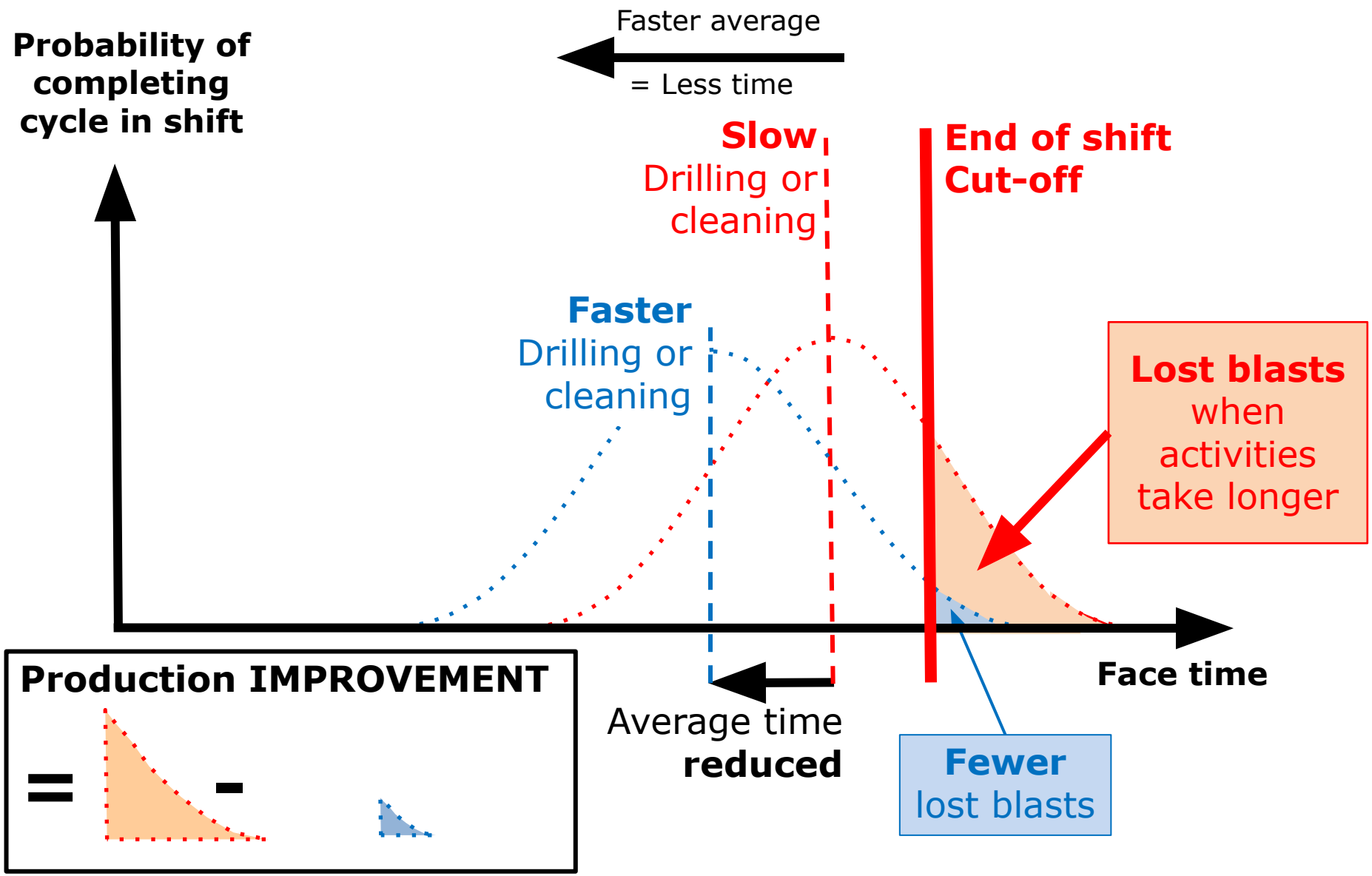
Rock throw blasted into gully

shifts curve to right

□ shorter cleaning times

- Short panels benefit from blast throw most
- Throw blasting requires:
  - Gully big enough
  - Drilling & face angles to aid blasting into gully not onto rock pile
- **Opportunity**: Twin Gully Split Panel (**TGSP**)

Faster ☐ More Blasts ☐ More PGMs



Production improvement

Example

- mine currently achieves **14 of 23 possible blasts** (ie 60% strike rate)
- faster drill & clean **reduces activity time by 1 hr**
- results in **28% higher production**

		Current strike rate				
		40%	**50%**	**60%**	**70%**	**80%**
Ave. reduction in time [hours]	**0.5**	21%	19%	16%	11%	6%
	0.75	31%	27%	23%	17%	11%
	1.0	38%	34%	**28%**	22%	14%
	1.25	45%	39%	33%	25%	17%
	1.50	50%	43%	35%	27%	18%

Improvements of 15 to 30% are possible

Actual results will depend on current performance, drilling & cleaning time reductions, & the ability to remove other bottle necks & delays

Water & energy usage

- **Water USAGE** [m3] = **TIME** x **DIVERSITY Factor** x Nozzle **FLOW RATE**

DIVERSITY Factor = Flow TIME / Cleaning TIME = ~75%

Allows for no-flow time when shut-off valve is closed eg set-up & move time

- PP **Power** [kW] = (**PRESURE** in MPa x **FLOW RATE** in l/s) / **EFFICIENCY**

- **Energy USAGE** [kWh] = Power in **kW** x Run **hours**

NOTE: Formulea simplified to highlight principles – See technical paper for details

Variation & accuracy

- Cleaning **TIME** = Total cleaning time including set-up, move-time, pack-up & typical delays

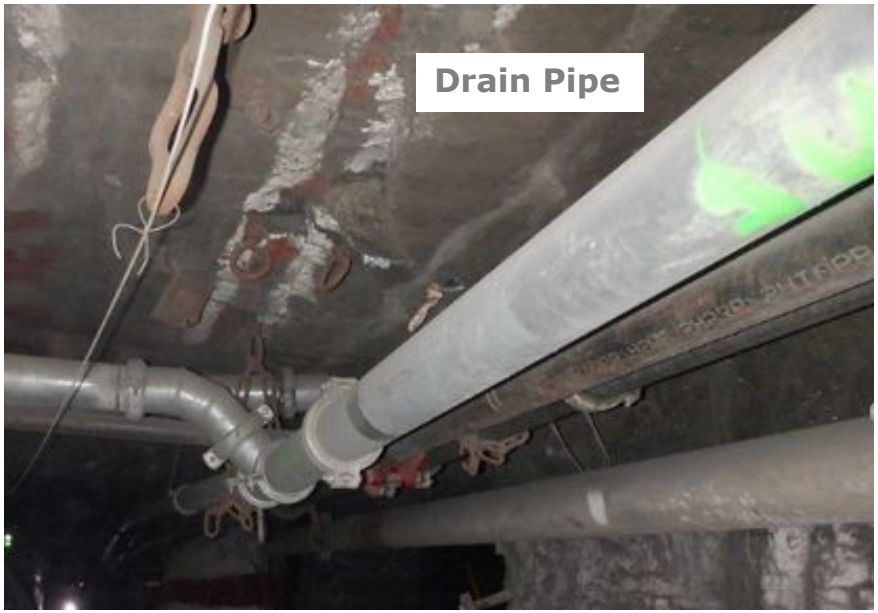
- **Varies** with:
  - fragmentation
  - footwall smoothness
  - blast throw
  - geological issues – rolls, steps
  - excessive over-size rocks
  - gully or raise scraper performance
  - etc

- **Accuracy**
  - Approximate due to nature of jet cleaning & difficulty of collecting data
  - Most accurate for changes close to a known data point
    - eg accurately predicts effect of panel length or stope width change
  - Power law correlation can be updated for additional measured TIMES

Handling Footwall H_2O .. best practice

- Jet pump in gully
- Lifts water off footwall into drain hose

50NB drain hose to drain pipe



- Hose connects into lateral branch
- Water gravitates down raise
- Drain pipe delivers water to haulage
- By-passes box via T-way or drain hole
- Allow grits to settle out
- Pump dirty water into dirty water pipe on level

water in raises & boxes ☐ mud on footwall COMMON to ALL mines ONLY with pumps & pipes can this be eliminated

Footwall (dirty) water CAN & MUST be managed ..

Issues to be addressed

- Safety

- Working environment
  - Positional cooling (if water chilled)
  - Water effectively removes heat
  - Ponding ☐ heating & humidification (bad, hence handle dirty water)

- Cleaning tool selection:
  - Auto shut-off versus dumping
  - Prop-mounted vs hand-held
  - PP to also supply water drills ie (HP vs LP tool)
  - PP type & location

- To get full benefit of Jet Cleaning & to remove scrapers must:
  - Adequate water service water supply (typ. 150NB)
  - Dirty Water Management pipes & pumps

Integrate cleaning with Drill Guides
☐ SAFETY improvement

Answers .. per UG2 panel

For 15° DIP, 0.85 m advance & 16 MPa at tool

1. Panel cleaning **TIME** **~5 hrs** (Merensky less)
2. Optimum panel **LENGTH** **< 25m** (Merensky longer)
3. Most suitable **jet cleaning tool** **Prop-mounted Panel Cleaning Tool, Ø 5,5mm**
4. **Production increase** possible **15 to 30%**
5. **Water** usage **52 m^3 /panel** or **0.42 m^3 /t** (Merensky similar)
6. **Energy** usage **5.6 kWh/t**
7. **Dirty water management** **jet pump & drainpipe**
8. **Other factors** to consider **better throw blast & drilling accuracy**
9. **Working environment** **chilled water** (if available) ☐ positional cooling

   minimize ponding ☐ pump water away
10. **Safety improvements** **Integrate prop-mounted c/tools with**

    Drill Guides & remove face scraper