



Mine Gold. Create Value.

Austmine 2019 Mining Innovation Conference Presentation

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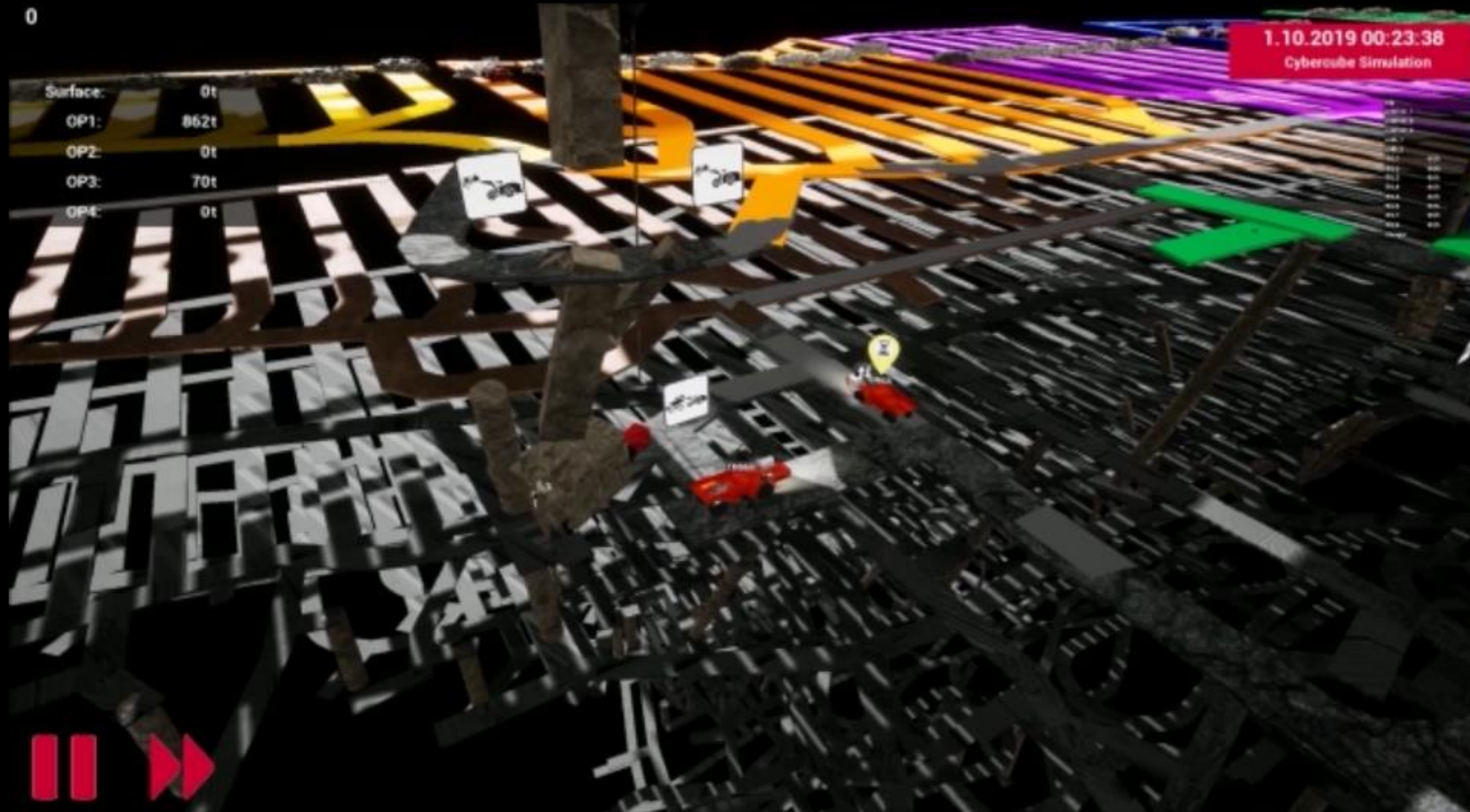
“I want to find a bold and innovative way to do things the same way its been done for the last 25 years.”

Syama Automation Project

Mining Smarter with Advanced Technology



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Syama Automation Project

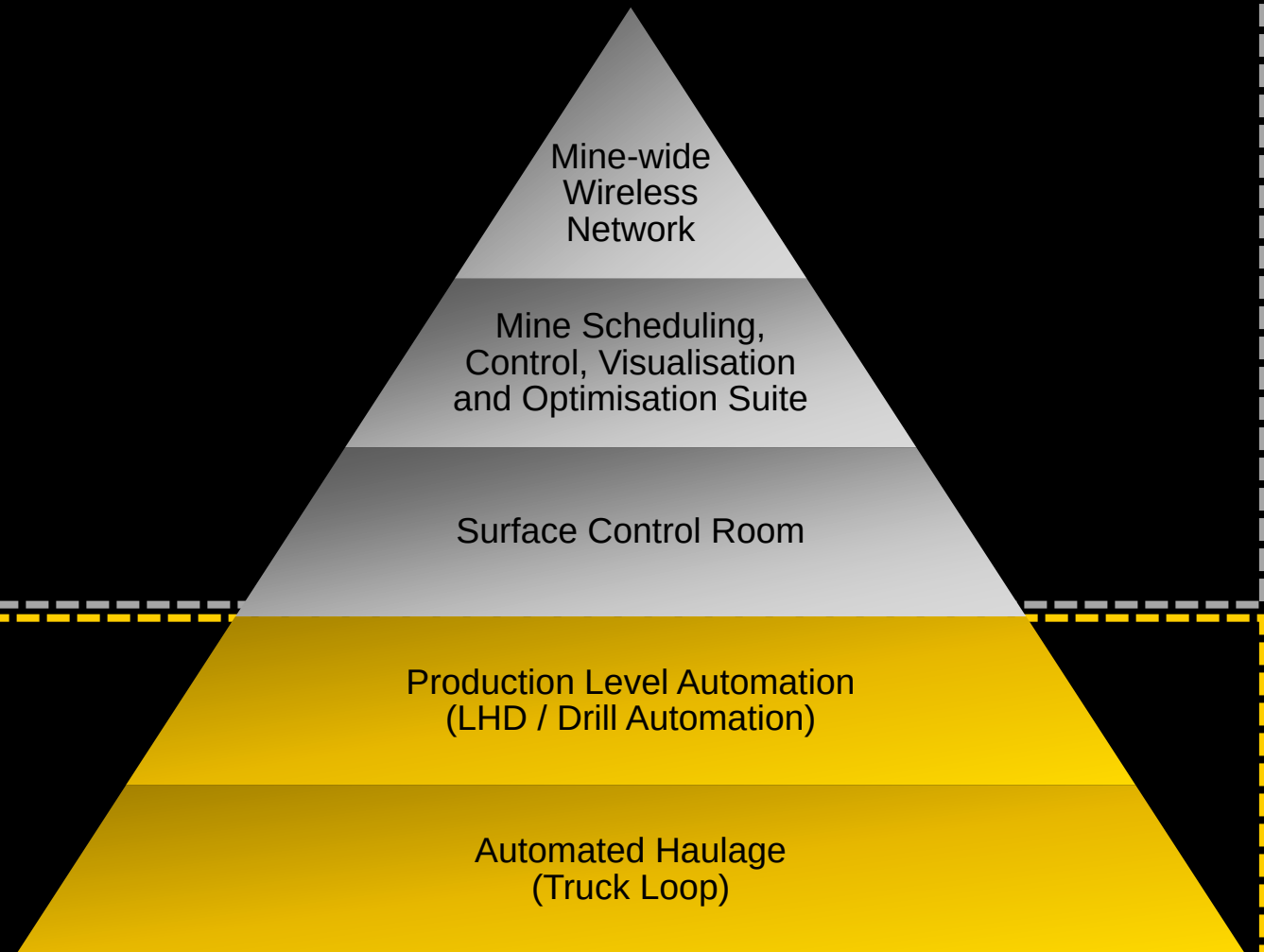
Major components

PHASE 1: MINE DIGITALISATION

PHASE 1 Capability delivers the completed control room with connection to the underground wireless network and the ability to schedule, control and monitor MANUAL underground activities in real-time.

PHASE 2: AUTONOMOUS PRODUCTION AND HAULAGE

PHASE 2 Capability delivers AUTOMATED LHD and DRILL Production on the levels and AUTONOMOUS truck haulage from the 1055 level to the surface ROM



Syama Automation Project

Phase 1

Control Room + Network + OptiMine = **Efficiency**

Both declines, and the 1105 and 1130 production levels will be connected to the visualisation system in the control room which will enable:

- Visualisation of mine and fleet (equipped with tracking units)
- Efficiency gains for production fleet
- Production gains for haulage fleet fitted with OptiMine units
- Remote production drilling
- Real-Time production data
- Real-Time dispatch
- Effective cave management



Syama Automation Project

Phase 2

Automated Haulage Loop - The Main Game

- The Automated Haulage Loop is the “Main Game” in terms of Syama’s delivered benefit from innovation.
- It gives us the ability to haul ore 24 hours a day / 7 days a week.
- Traffic is managed by a centralised server which increases the throughput over manual hauling.
- Higher production rates over more hours per day = more tonnes.



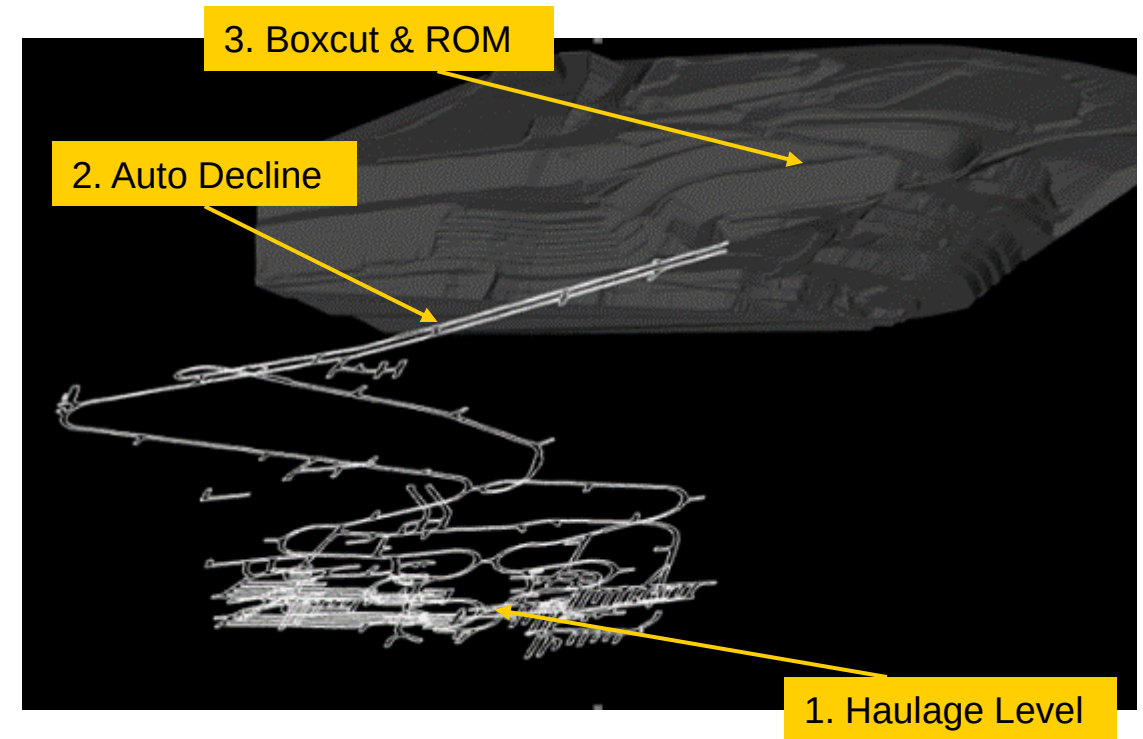
Syama Automation Project

Phase 2

Automated Haulage Loop - The Main Game

The Automated Haulage Loop Consists of three sections:

1. **Haulage Level** – This is where the autonomous trucks are loaded underground by the remotely operated LHDs. The ore is taken from the ore passes which are fed by the production levels.
2. **Autonomous Decline** – The mine has a segregated autonomous decline with passing bays where the autonomous trucks make their way to the surface.
3. **Boxcut & ROM** – After leaving the underground mine the trucks tram up the boxcut and to the ROM where they dump.





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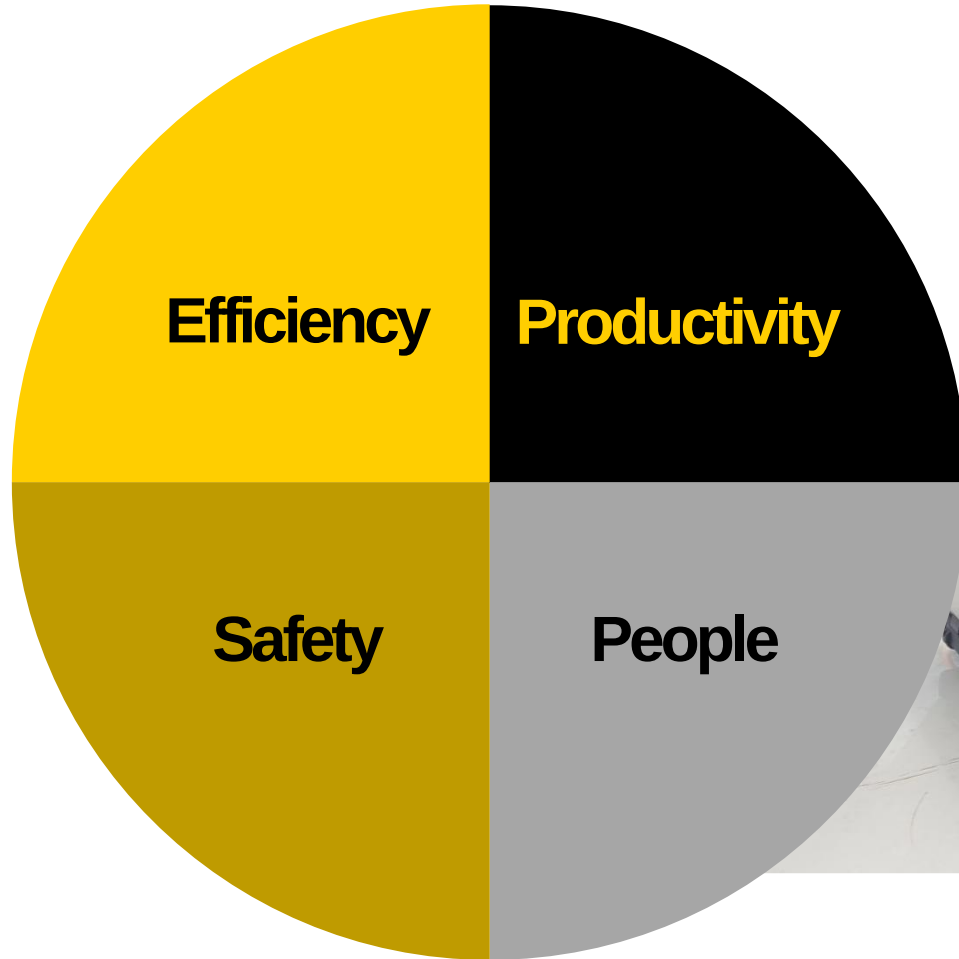
YOU'RE CRAZY!

Why would anyone try to implement the world's most complex underground mining production automation system in West Africa?



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The drivers for automation



The drivers for automation:

Safety

Underground mines present a number of hazards – particularly where there is not a high level of experience. To keep our people safe we will need to limit exposure to hazards:

1. Ground Failure
2. Mud / Fines Rush
3. Vehicle Interactions
4. Whole Body Vibration
5. Dust



The drivers for automation: Safety

The past

Our Mission is to identify those things we are doing now that people will look back at in 20 years and ask:

“How did we allow that to happen?”



The drivers for automation: Safety

The past: Engineered control

- Hazard and personnel still in close proximity
- Failure of the control leads to the human and hazard in the same place at the same time

Cage the hazard



Cage the Human



The drivers for automation: Safety

Moving forward: Out of harm's way





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The drivers for automation: Safety

Moving forward: Out of harm's way

Dr. Joe Cronin

Resolute's Automation
Project Manager



Resolute

Dr. Joe Cronin

Resolute's Automation
Project Manager

The drivers for automation: Safety

The Future: Operators separated from the level



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The drivers for automation:

Efficiency

Increasing operational efficiency by:

- 1.** The ability to control production at a reliable rate.
- 2.** The ability to optimise the production process
- 3.** Real-Time compliance data
- 4.** The ability to feed back real-time data for closed-loop process control
- 5.** Reduction in operator costs
- 6.** Potential to lower damage costs and downtime as control systems become smarter

The drivers for automation:

Productivity

Higher production rates and greater recovery from:

1.

The ability for higher throughput at a greater rate of recovery when operating at optimum parameters

2.

The ability to optimise return over a longer period (full production over shift change, blasting and re-entry)

3.

The reduction in variability due to operators

4.

The ability to selectively produce from drawpoints to optimise grade



The drivers for automation:

Productivity

- Underground productivity is highly variable and dependent on decisions made by personnel and supervisors
- Situational awareness, the ability to communicate and real-time feedback are essential for success

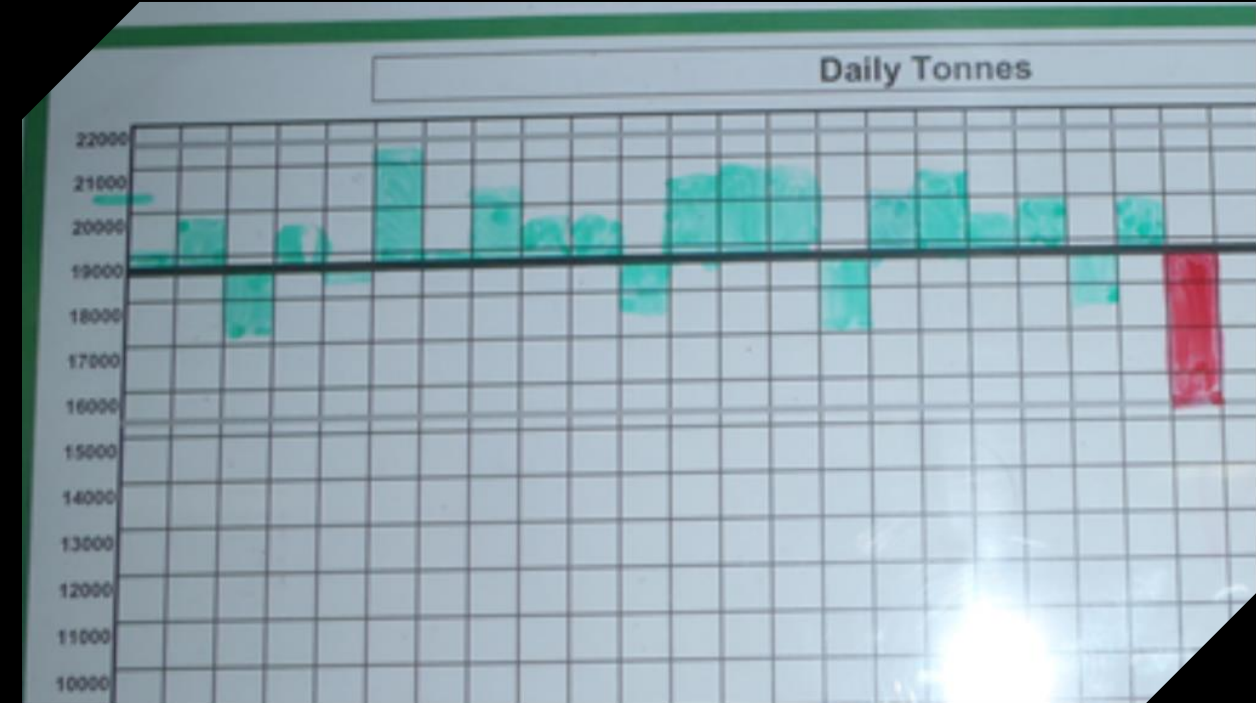


The drivers for automation: Productivity

Moving to real-time feedback

We can look back to see how many **Green** and **Red** days we have had, but we don't know WHY!

We need to ask; How are we going right now? What do we need to do to make this day a **Green** day.



“There's a reason the rear view mirror is so much smaller than the windscreen”

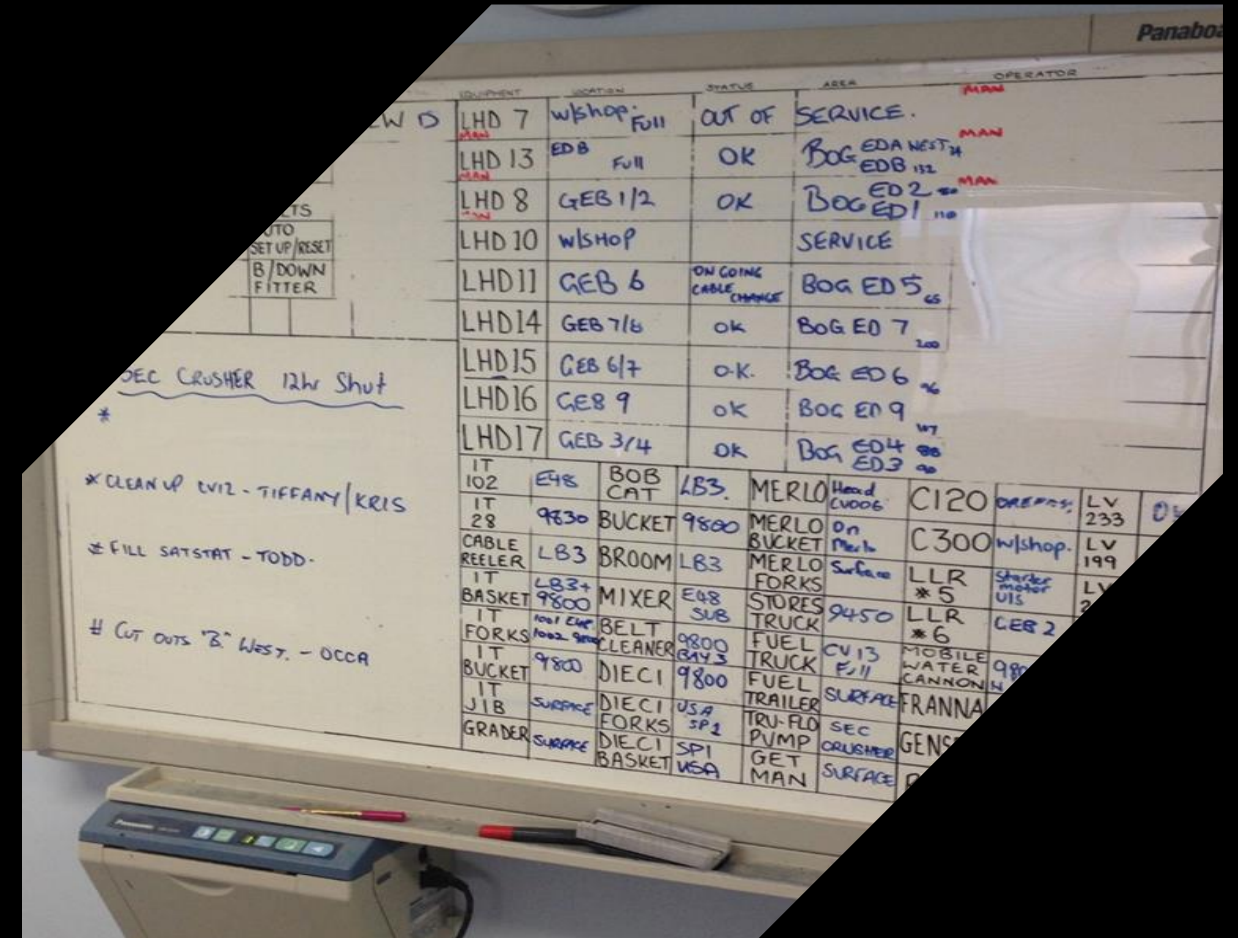
Old Swedish Saying

The drivers for automation: Productivity

Moving from open loop to close loop control

OPEN LOOP: How We Work Now

- Within the first hour, breakdowns will force us to change the plan.
- Too complex to analyse the effect of our decisions in real time.



EQUIPMENT	LOCATION	STATUS	AREA	OPERATOR
LHD 7	Wshop. Full	OUT OF SERVICE		
LHD 13	EDB Full	OK	BOG EDA WEST 112	MAN
LHD 8	GEB 1/2	OK	BOG ED 2 110	MAN
LHD 10	WSHOP		SERVICE	
LHD 11	GEB 6	ON GOING CABLE CHANGE	BOG ED 5 65	
LHD 14	GEB 7/6	OK	BOG ED 7 200	
LHD 15	GEB 6/7	OK	BOG ED 6 76	
LHD 16	GEB 9	OK	BOG ED 9 117	
LHD 17	GEB 3/4	OK	BOG ED 4 98	
IT 102	E48 BOB CAT	LB3	MERLO Head CVO06	C120
IT 28	9830 BUCKET	9800	Merlo on	C300
CABLE REELER	LB3 BROOM	LB3	Merlo Surface	LLR *5
IT BASKET	LB3+ 9800	MIXER	Merlo 9450	LLR *6
IT FORKS	1001 Clap 1002. 9800	BELT CLEANER	9800	FUEL TRUCK
IT BUCKET	9800	DIECI	9800	FUEL TRUCK
IT JIB	SURFACE	DIECI	USA	FUEL TRAILER
GRADER	SURFACE	DIECI	SP2	TRU-FLO PUMP
		DIECI	SPI	GET MAN
		BASKET	USA	SURFACE

DEC CRUSHER 12hr Shut

* CLEAN UP LV12 - TIFFANY/KRIS

* FILL SATSTAT - TODD

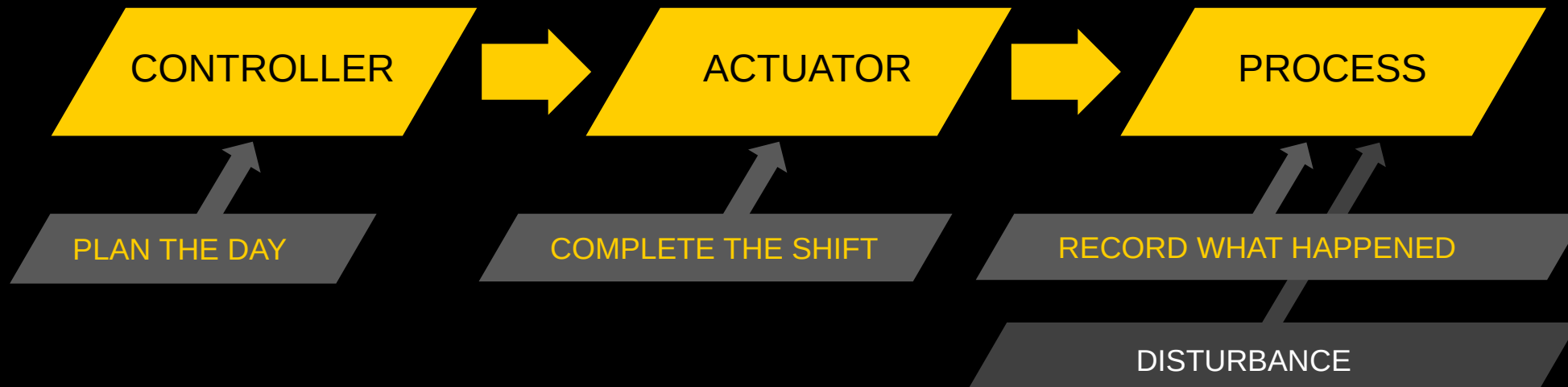
CUT OUTS "B" West. - OCCA

The drivers for automation: Productivity

The past

Moving from open loop to closed loop control

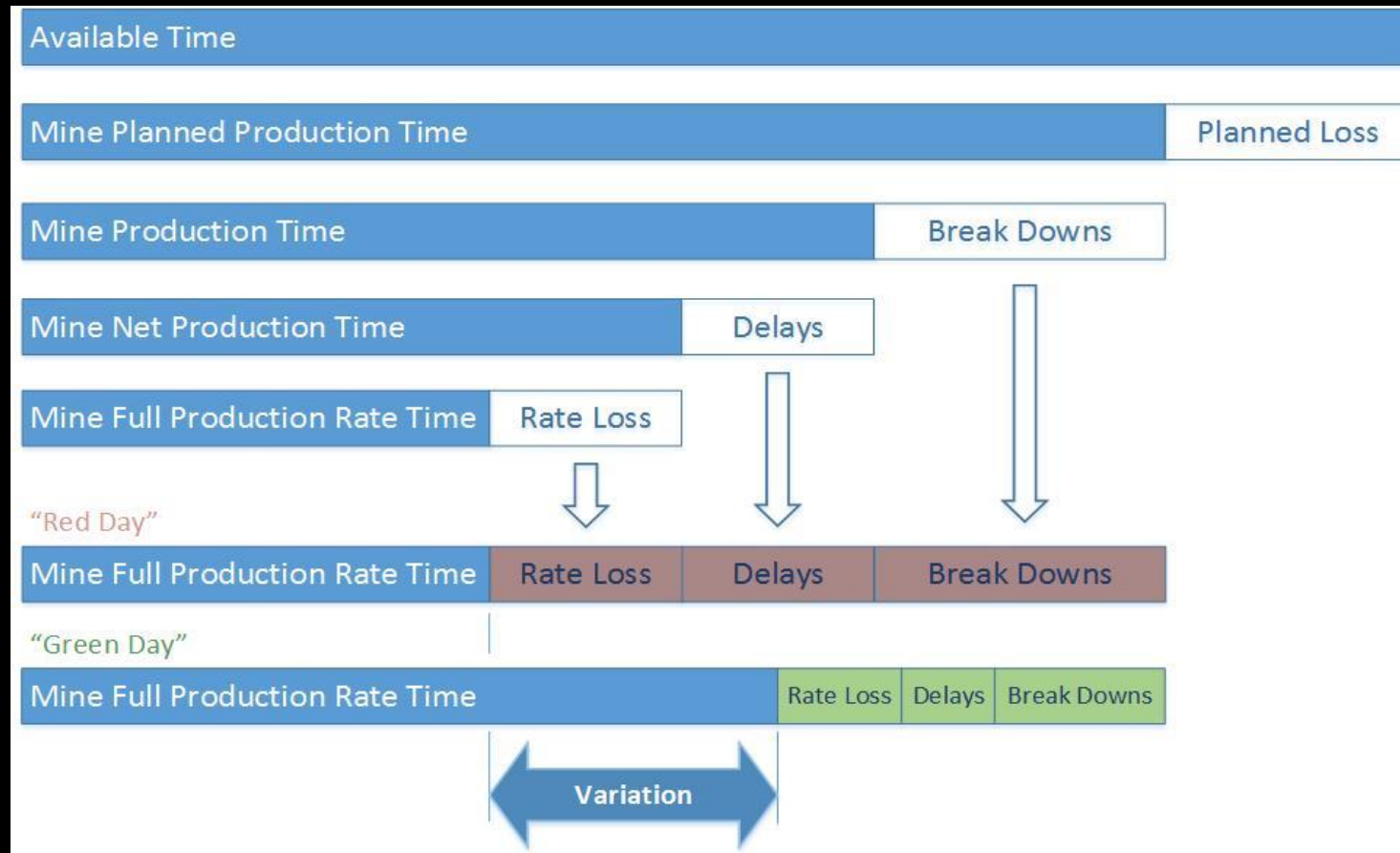
OPEN LOOP: how we have worked in the past



The drivers for automation: Productivity

The ability to control the output

VARIATION IN UNDERGROUND PRODUCTION



The drivers for automation: Productivity

The ability to control the output

Variation in underground production represents a loss of control of our process:

1. DATA
2. SAFETY
3. COSTS
4. SCHEDULING
5. PRODUCTION
6. RISK



The drivers for automation: Productivity

The ability to control the output



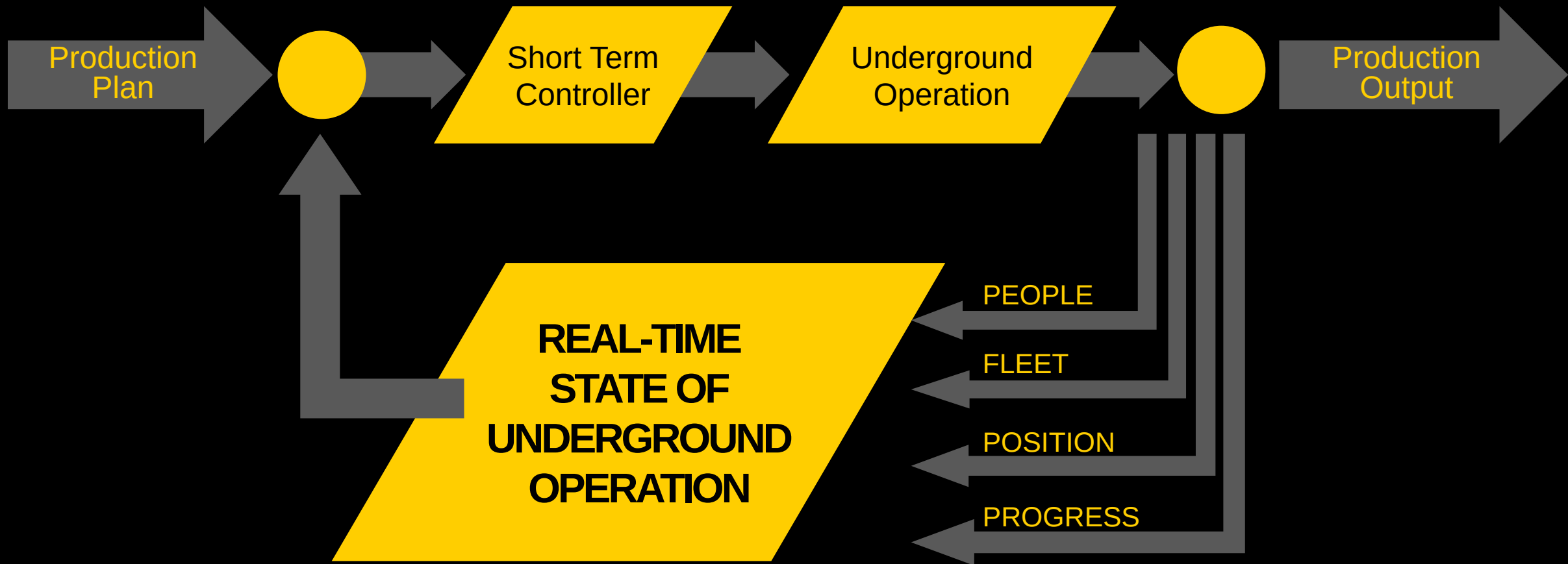
VARIATION reveals itself in

1. Higher INJURY rate
2. Higher operating COSTS
3. Lower and less predictable PRODUCTION
4. Lower UTILISATION OF ASSETS
5. Lower EMPLOYEE ENGAGEMENT

The drivers for automation: Productivity

The future

CLOSED LOOP: how we will work in the future



The drivers for automation: People



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The drivers for automation: People

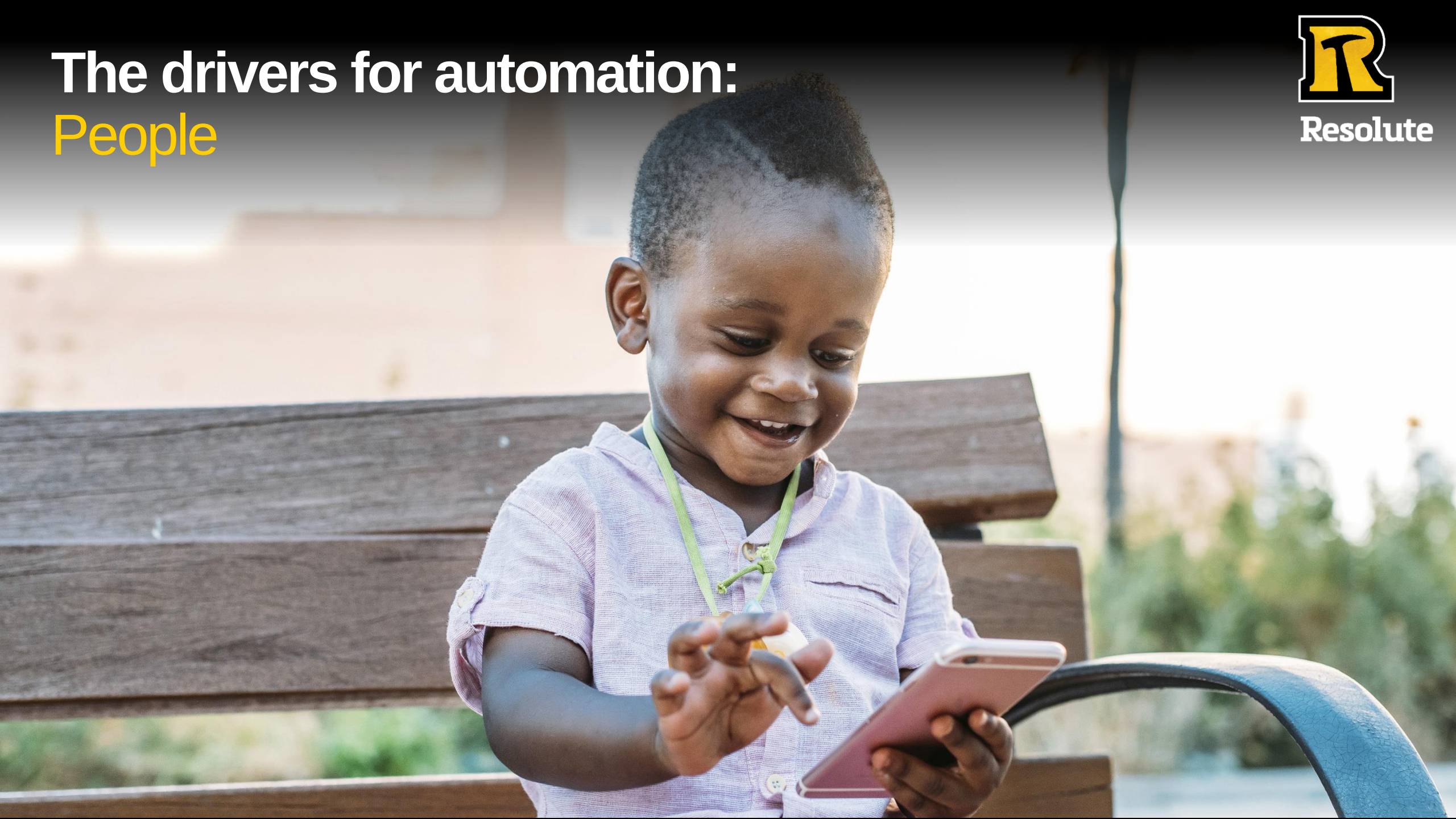
The Malian Talent Development Program

The drivers for automation:

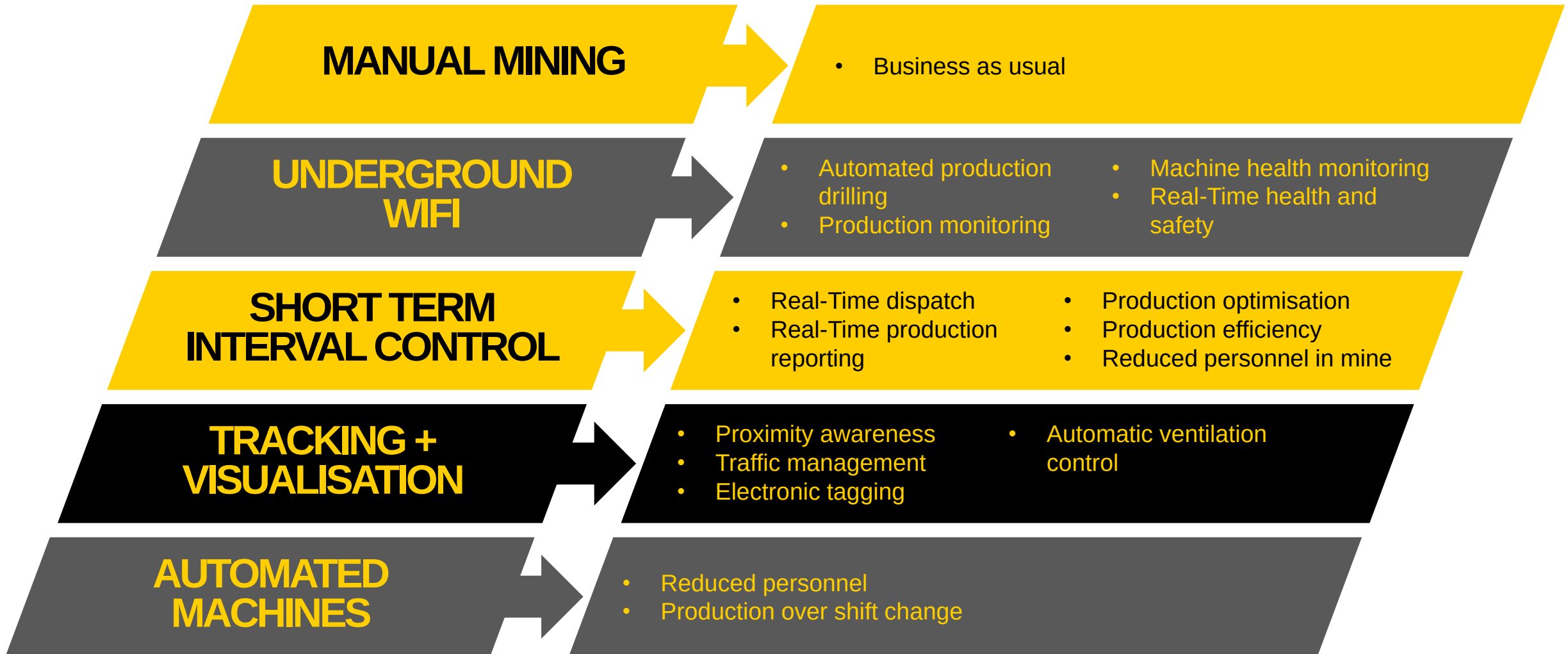
People



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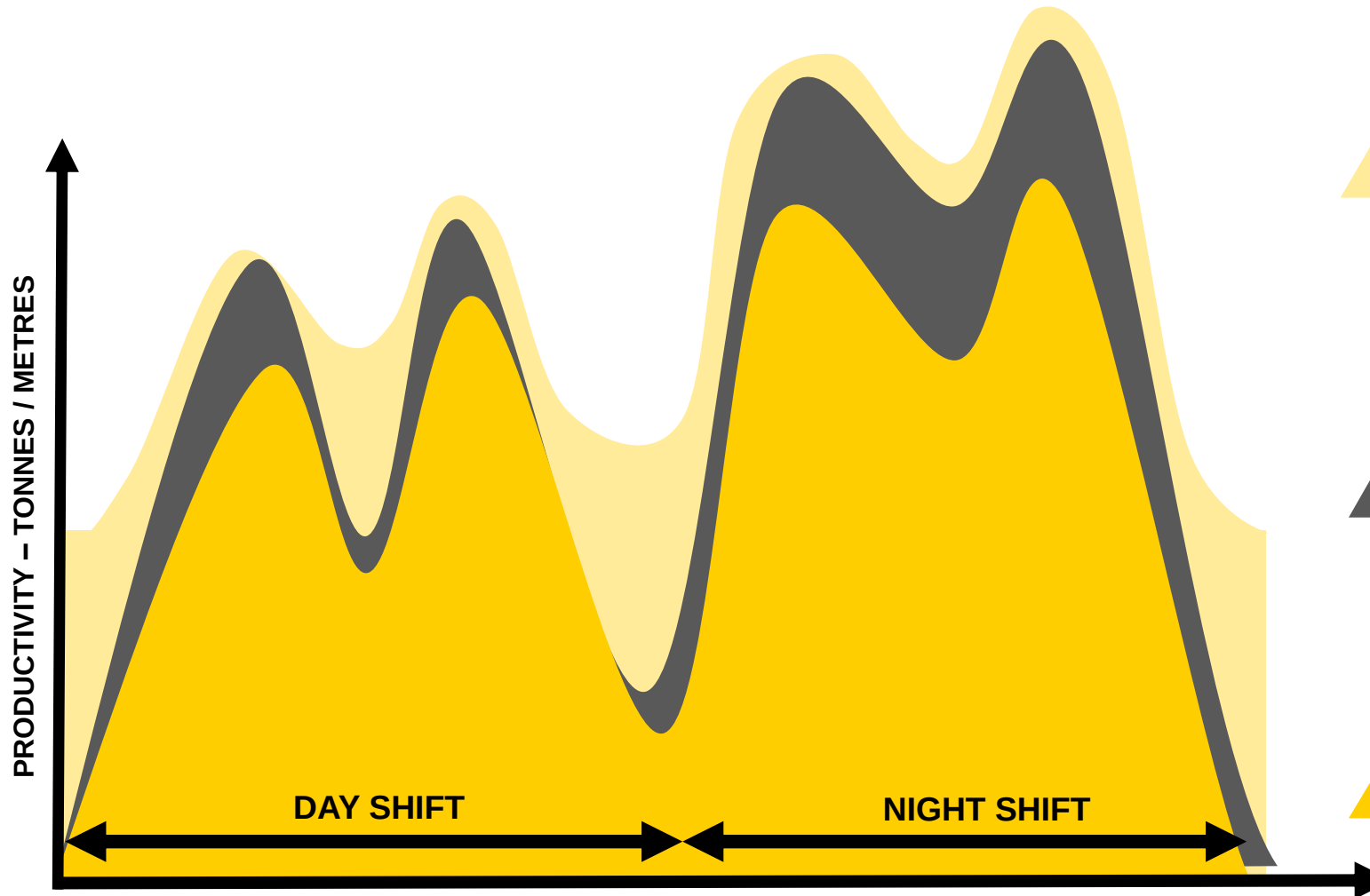


Capability based technology strategy



Optimised automated production

Additional production from technology



AUTOMATED MINE 15% - 20% Gain

- Remotely Operated Machinery
- Autonomous Drilling
- Autonomous Haulage

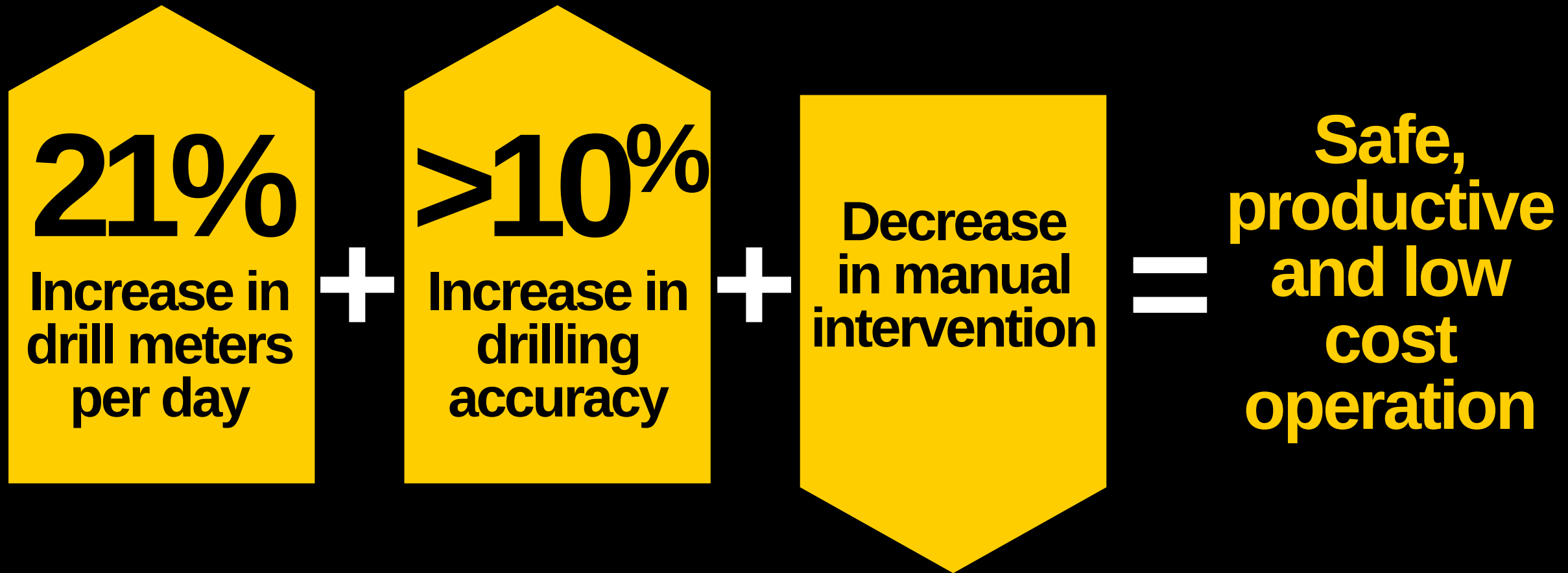
DIGITAL MINE 10% - 15% Gain

- Tracking and Visualisation
- Task Scheduling and Optimisation

MANUAL MINE

Early Results:

Automated drilling



The World's first purpose built fully automated underground gold mine

You would be **CRAZY** not to !



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Mine Gold.
Create Value.