DESIGNING FOR BENCHMARK
Longwall mine of the Future

Real Mining. Real People. Real Difference.

ANGLO AMERICAN

A global player with a market cap of US$33 billion

Key

- 🔵 Headquarters
- ⚪ Corporate & representative offices
- 🔴 Iron Ore and Manganese
- ⚫ Metallurgical Coal
- ⚫ Thermal Coal
- 🟠 Copper
- 🟡 Nickel
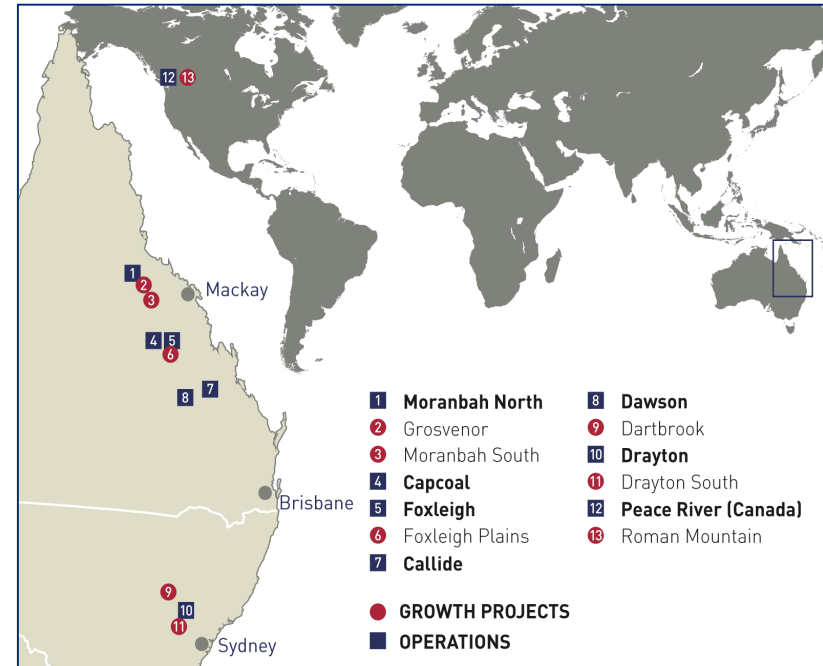- 🔵 Platinum
- 🟣 Diamonds
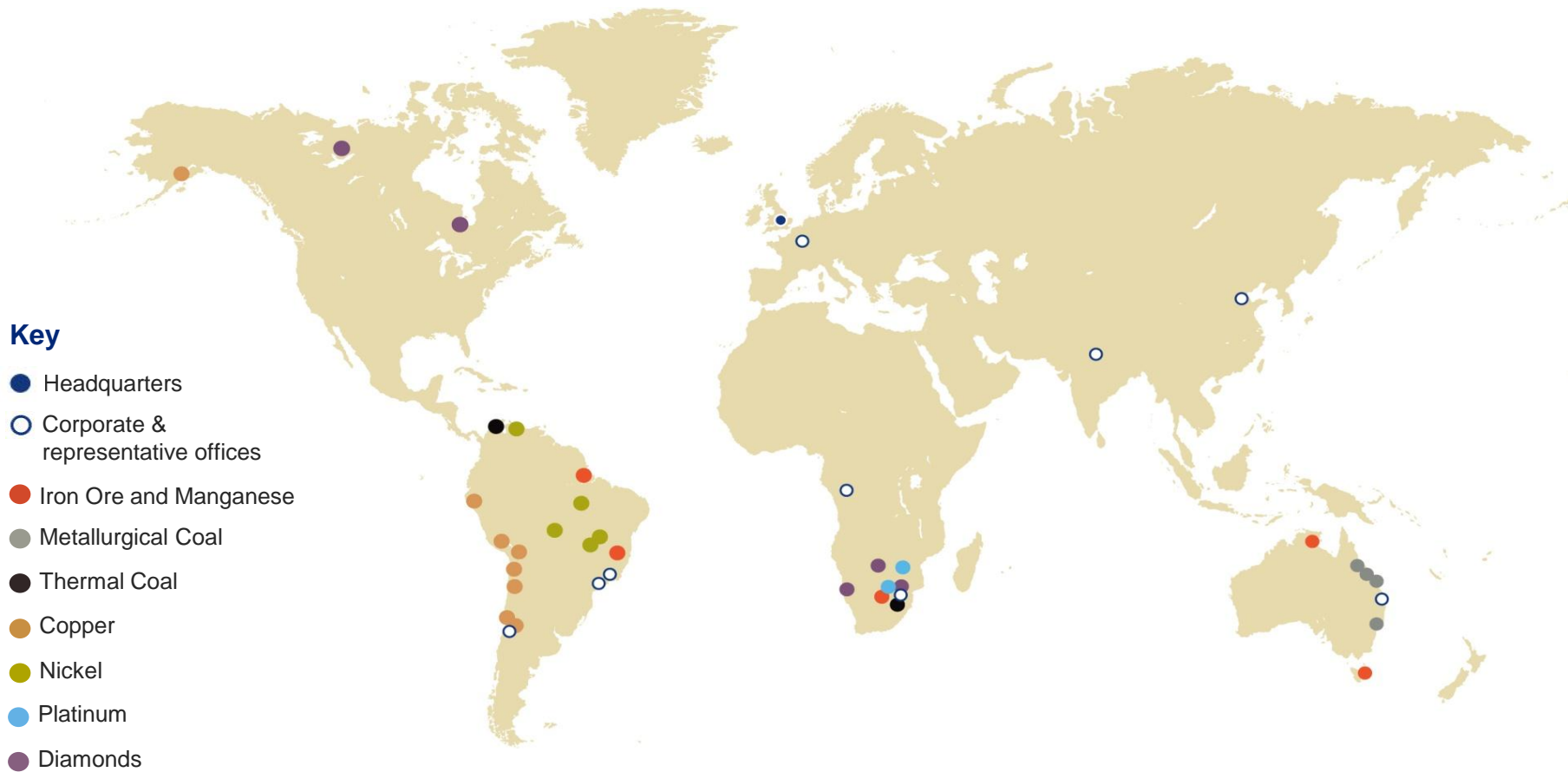
145,000 permanent employees with operations in Africa, Asia, Australia and North and South America.

A GLOBAL METALLURGICAL COAL BUSINESS

With a strategy to grow metallurgical coal production

- Access to more than 100 years of coal resources, with more than five billion tonnes of hard coking coal inventory close to ports in our regions

- Second largest exporter of metallurgical coal in Australia and third largest global export metallurgical coal producer

- We produce a large range of premium hard coking coal products, coking coal blends, PCI for use in the steel industry and thermal coal for power utilities

- Six mines in Queensland and New South Wales; one metallurgical coal mine in British Columbia

- Two waste coal mine gas methane-fired power plants

- Five growth projects:
  - Grosvenor (Qld), 100%
  - Moranbah South (Qld), 50%
  - Drayton South (NSW), 88%
  - Dartbrook (NSW), 88%
  - Roman Mountain (BC) 100%

- Access to Abbot Point, Dalrymple Bay, Gladstone and Newcastle ports and Ridley Island in BC

1	Moranbah North	8	Dawson
2	Grosvenor	9	Dartbrook
3	Moranbah South	10	Drayton
4	Capcoal	11	Drayton South
5	Foxleigh	12	Peace River (Canada)
6	Foxleigh Plains	13	Roman Mountain
7	Callide		

● GROWTH PROJECTS
■ OPERATIONS

3

THE IMPERATIVE FOR BENCHMARK PERFORMANCE

Four new longwalls in the some of the best coking coal

Metallurgical Coal's strategy is to double metallurgical coal production by 2020:

- Underground project pipeline, targeting a production level of between 35Mt and 40Mt of product coal by 2020
- Delivering longwall productivity at world's leading practice in terms of safety and productivity

The intention of Met Coal and the purpose of the Longwall Mine Of the Future Project is, in partnership with Joy Global, to establish the design to achieve the capability to operate the operations in the Moranbah Region:
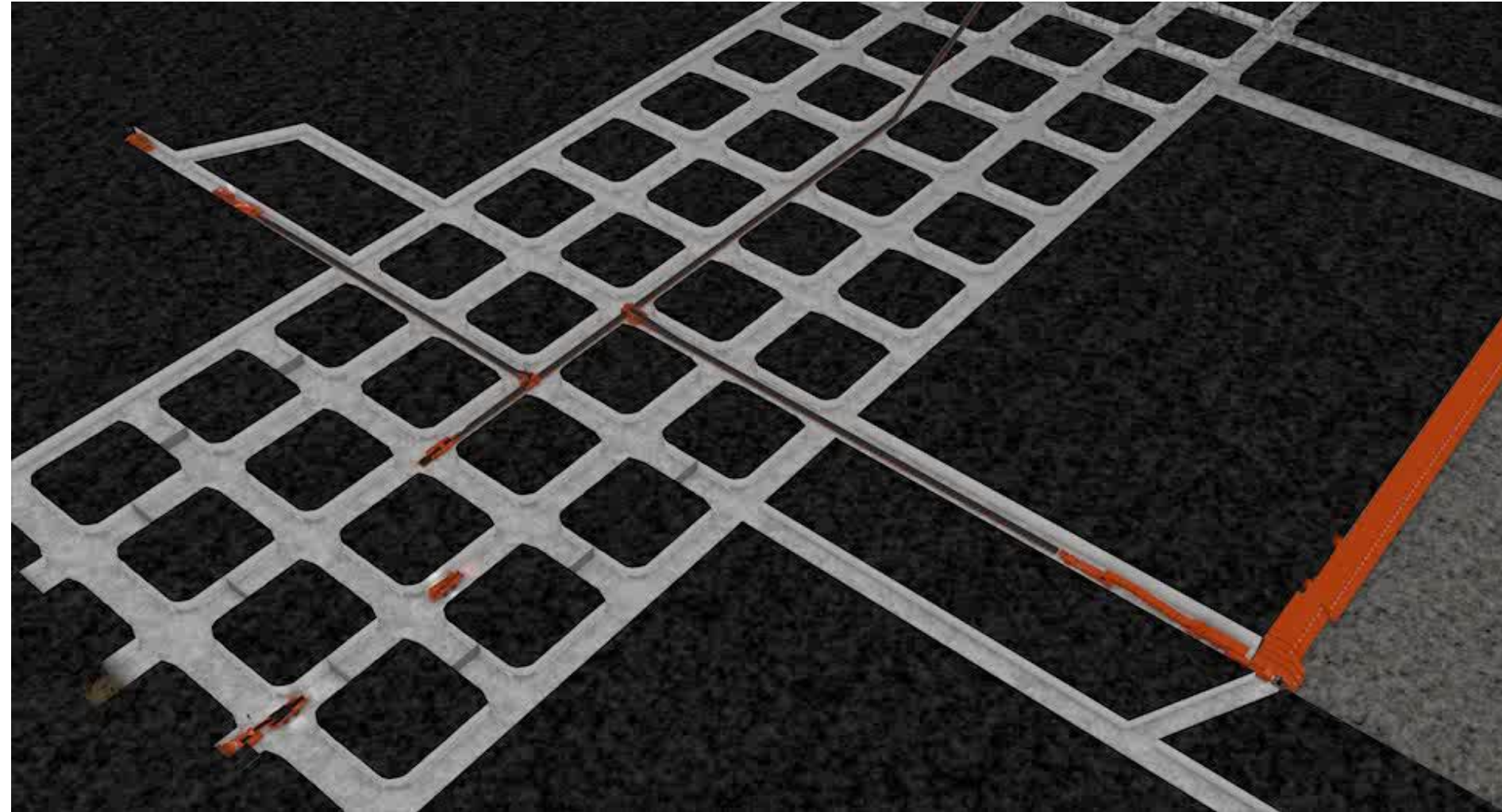
- Safely with Zero Harm (Remote operation)
- At 2200 tonnes per hour on average
- At 120 cutting hours per week on average
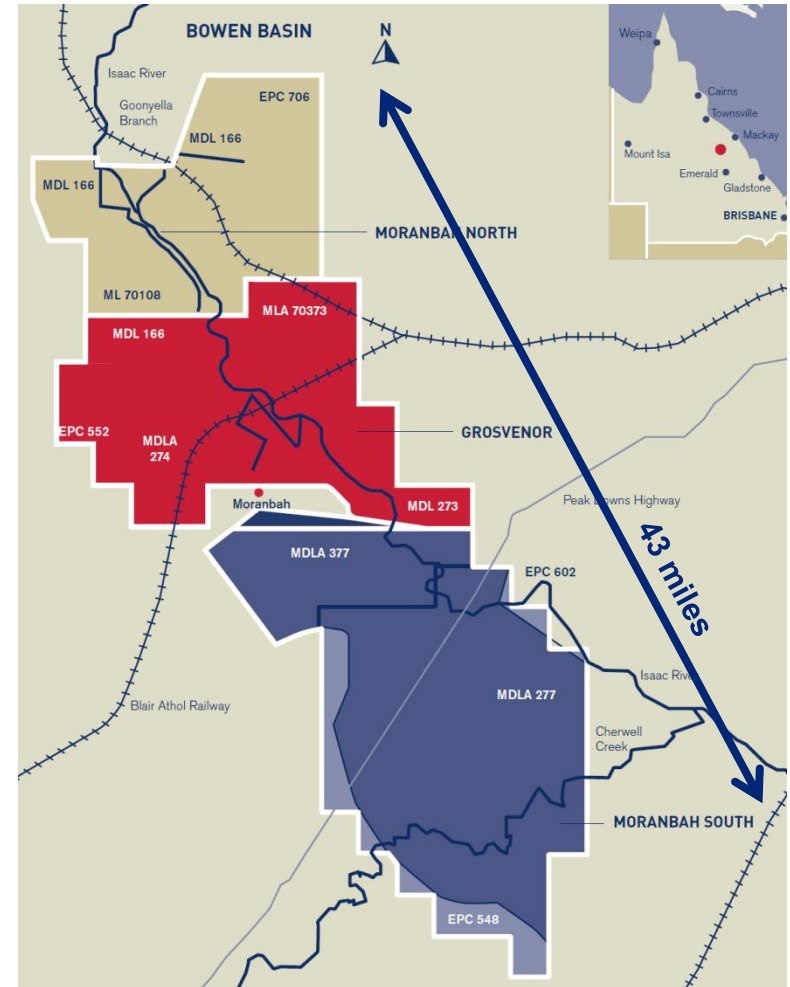
We needed stretch achievable goals that the partnership could be design around

THE VISION – LONGWALL MINE OF THE FUTURE
Make it safer, faster and run longer ……

SET STRETCH PARTNERSHIP GOALS THAT ARE ACHIEVABLE ….

Grosvenor

	BLOCK 1	BLOCK 2	BLOCK 3	BLOCK 4	BLOCK 5
SAFETY	Remote operations from gate end			Remote operations from surface	Remote operations from surface
CUTTING RATE T/HR	1700	2000	2200	2200	2200
CUTTING UTIL. HRS/WK	80	95	105	120	120

Grosvenor 2

	BLOCK 1	BLOCK 2	BLOCK 3	BLOCK 4
SAFETY	Remote operations from gate end		Remote operations from surface	Remote operations from surface
CUTTING RATE T/HR	2000	2200	2200	2200
CUTTING UTIL. HRS/WK	90	105	120	120

Moranbah South 1

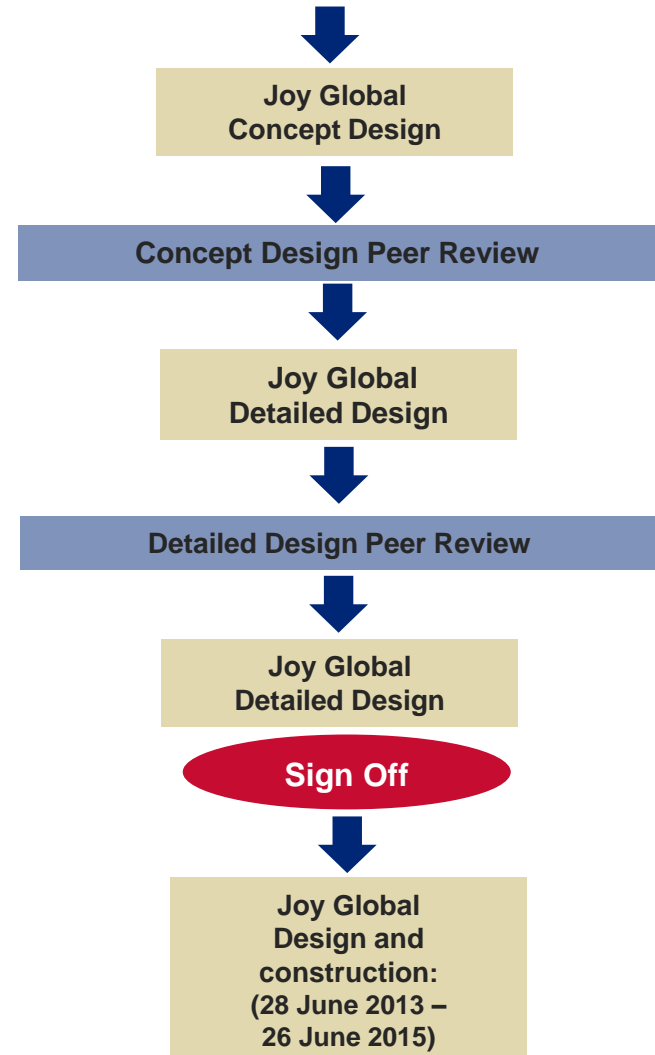|	BLOCK 1	BLOCK 2	BLOCK 3
SAFETY	Remote operations from gate end	Remote operations from surface	Remote operations from surface
CUTTING RATE T/HR	2200	2200	2200
CUTTING UTIL. HRS/WK	90	105	120

Moranbah South 2

	BLOCK 1	BLOCK 2
SAFETY	Remote operations from surface	Remote operations from surface
CUTTING RATE T/HR	2200	2200
CUTTING UTIL. HRS/WK	90	120

COLLABORATION FOR DESIGN EXCELLENCE
The quest for benchmark requires an expansive and collaborative approach to design

- The partnership defines what's needed to achieve benchmark performance

- Supplier then decides how best to achieve the outcome

- 2 layers of design detailing. Get the macro issues right, then sweat the detail and involve the operators!

- Design challenge by operators – Multi level review

- Design challenge by industry leaders and subject matter experts

- Supplier accountable for all aspects of design

- User endorses design once all on board

Joint Functional Design Input workshops

⬇

Joy Global Concept Design

⬇

Concept Design Peer Review

⬇

Joy Global Detailed Design

⬇

Detailed Design Peer Review

⬇

Joy Global Detailed Design

Sign Off

⬇

Joy Global Design and construction: (28 June 2013 – 26 June 2015)

CONTINUOUS IMPROVEMENT

Start with the belief that you had it all wrong, challenge convention and entrenched assumptions

Analyse the gap

Extract the opportunities (850 identified)

Improvement Focus area	Benefit to safety	Benefit to Hours / week	Benefit to Cutting rate.
1. Safety Review	168 Mods	–	–
1. Historical Delay Review and Peer Review	–	42 Hrs / Wk (543 Mods)	-
5. Benchmarking	19 Mods	5 Hrs / Wk	–
3. Maintenance review (Feb 13 to July 13)	In Progress	In Progress	-
4. Cutting rate review	–	–	+ 990 t/hr (120 mods)
LAS Cycle			300 t/ hr
Bi Di			250 t/ hr
Automation			150 t/hr
Horizon Control			120 t/hr
Wider Face (Potential)			75 – 170 t/ hr

TEAM INPUT

Tap into the collective feedback of our experienced operators

| Longwall System Analysis completed * | → | Functionality required based on Task review. | → | Detailed, executable 5 year Automation Journey project plan |

Review longwall team and their work content.

Task listing during normal operations including exception tasks.

Face Control
- Face Alignment
- Horizon Control
- Creep Management

Face Management
- Geology sensing and response
- Roof support collision avoidance
- Exception identification, notification, reporting and rectification
- Visualisation Function

System Integration
- Communication systems
- Operational Performance optimsation

Functions required for 2013 for Bi Di @ Moranbah

Functions required for 2016 for Bi Di and Remote operation from Main Gate at Grosvenor

Functions required for 2019 for Bi Di and Remote operation from surface at Grosvenor & Grosvenor 2

LONGWALL MINE OF THE FUTURE AUTOMATION SCHEDULE

Automation Project task groups	2012	2013	2014	2015

Automatic face Straightening project
- Improving the functionality of LASC
- Manual Face Straightening
- Fully Auto Face Straightening

Longwall Face Creep Management
- Manual deviation measurement & Manual correction
- Manual deviation measurement and autocorrection
- Auto deviation measurement and autocorrection

Gate End Automation
- Advanced Shearer Automation optimisation

Position Control (Shearer / PRS anti collision)
- Smart Shearer to determine tip position Design
- Smart Support to determine tip position Design
- Tip Position Established
- Position Control. (Collision Avoidance in place)

Visualisation and Sensing (Remote operations)
- Shearer Camera
- Chock Cameras
- Longwall, AFC, PRS Sensing equipment
- Smart Shearer Camera Support

Automated Face position in Seam Operations
- Technology Review
- Camera (Visible Light Frequency sensing)
- Gamma Radiation position sensing
- Thermal Sensing
- Radar Positioning
- Geology - Seam position accuracy improvement
- Establish the plan to progress
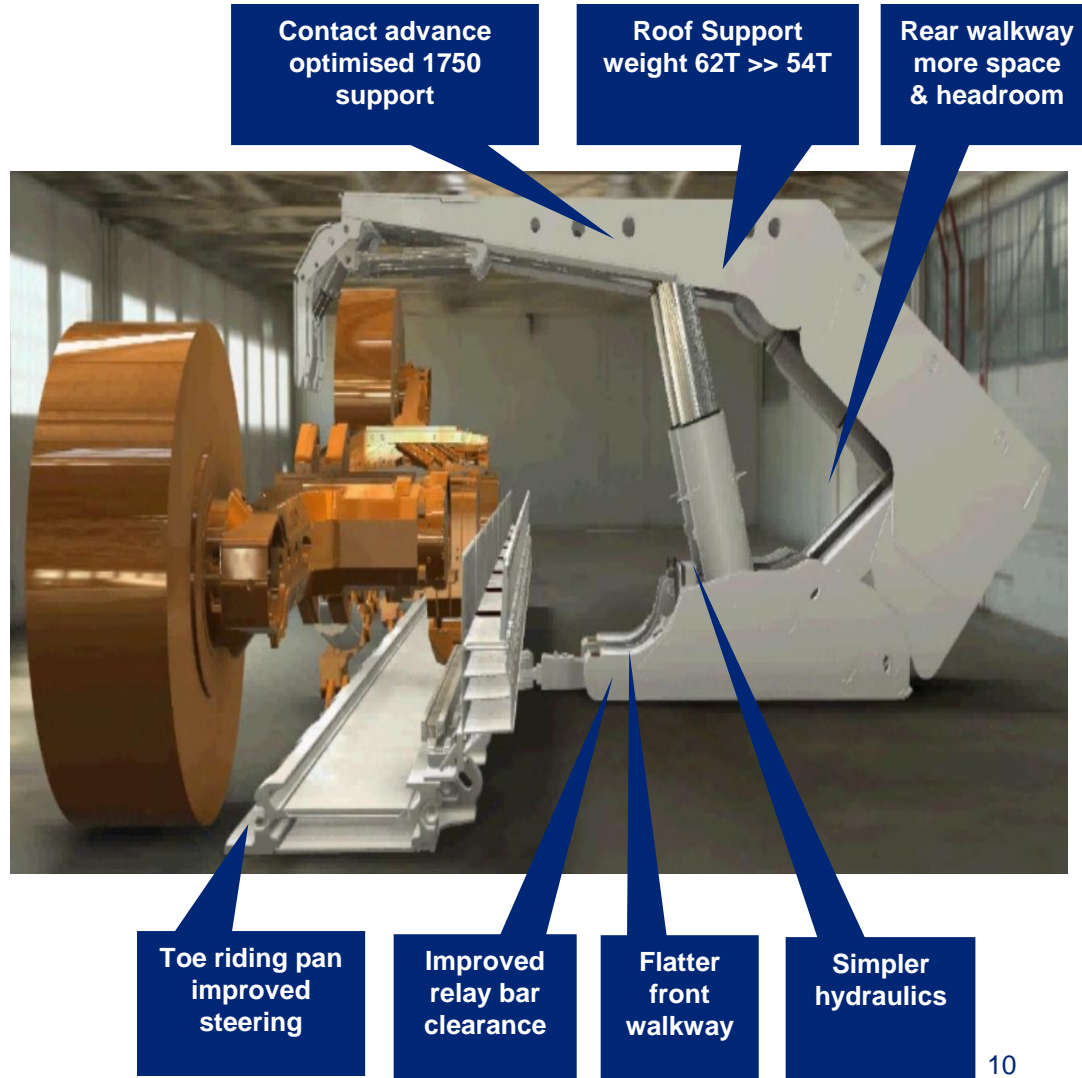
In Search of the Holy Grail !

Longwall Operations Analysis with Moranbah Operators, Tradesmen and Automation Engineer + Joy UK Tech staff.

KEEP IT SIMPLE
Control the geotech, automate, the rest will come …

- 1750T Roof Support design to target
  - Lower weight
  - Hydraulic reticulation improvements

- Optimised tip to face and web depth to preserve optimum geotechnical performance

- Achieving 2200TPH with good roof conditions means single chock advance critical and requires a Roof Support cycle time of less than 11 seconds

- Reduced weight of Roof Support provides better in wall clearances and facilitates easier LW moves .

- Automation key to control and elimination of variability.

Contact advance optimised 1750 support

Roof Support weight 62T >> 54T

Rear walkway more space & headroom

Toe riding pan improved steering

Improved relay bar clearance

Flatter front walkway

Simpler hydraulics
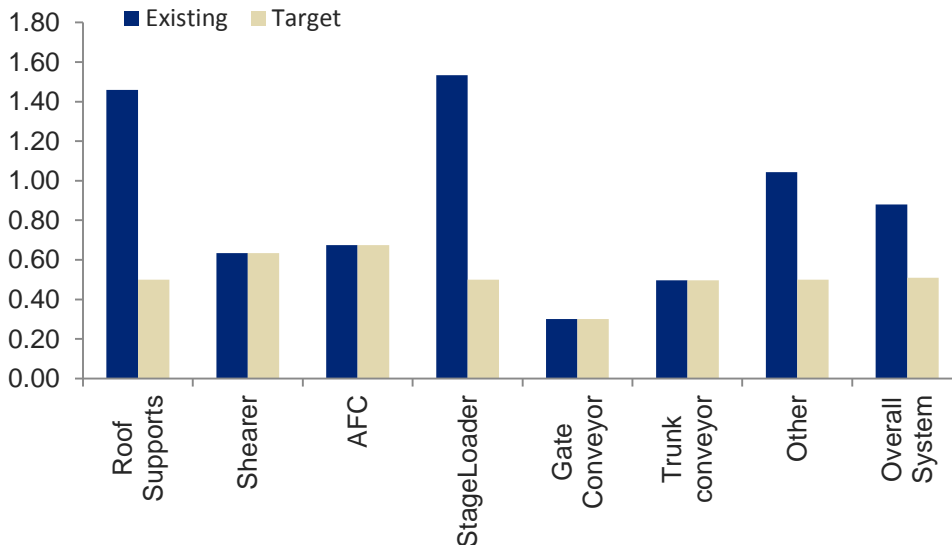

How do we design for reliability? …

RELIABILITY

The devil and the detail share the same zip code …………….

Component MTBF Improvement: hours
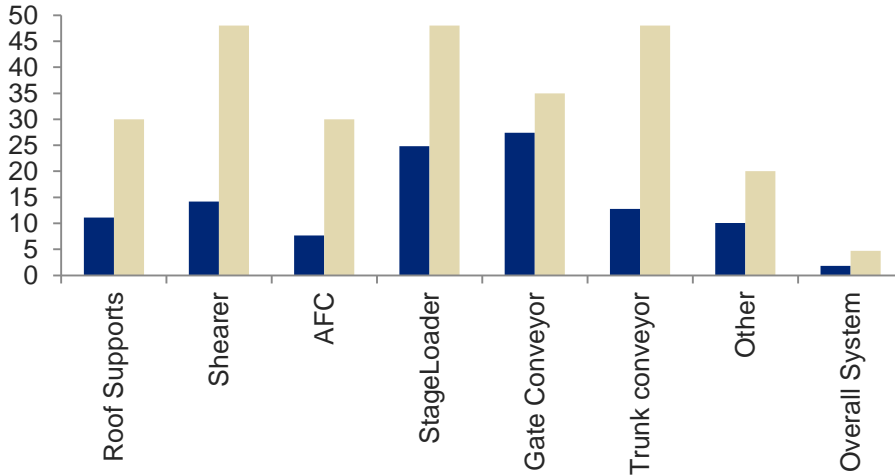
Component MTTR Improvement: hours

	ACTUAL*		TARGET	
	MTBF	MTTR	MTBF	MTTR
Roof Supports	11.14	1.46	30	0.50
Shearer	14.16	0.63	48	0.63
AFC	7.67	0.67	30	0.67
Stage Loader	24.84	1.53	48	0.50
Gate Conveyor	27.38	0.30	35	0.30
Trunk conveyor	12.76	0.50	48	0.50
Other	10.09	1.04	20	0.50
Overall System	1.80	0.88	5	0.51

- Simulation using Simio technology. (Discreet Event Simulation model)
- System throughput target set at 120 hours to understand MTBF required by component.
- Review of proposed changes to asses benefit by component.
- Implement design changes through Reliability Centred Maintenance process.
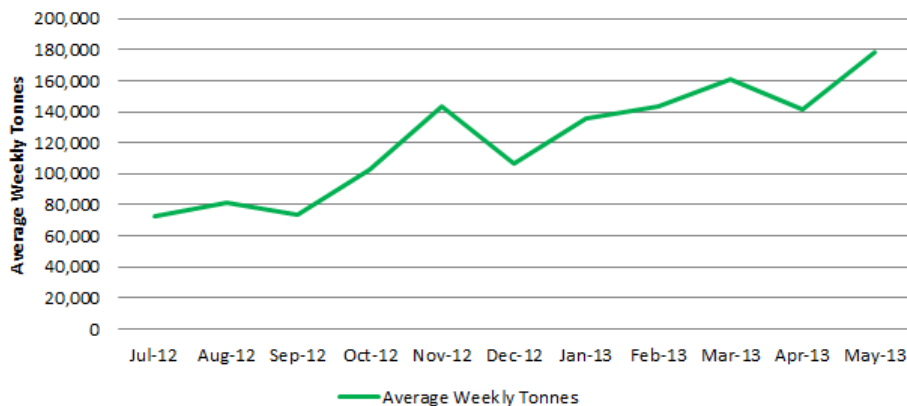
MORANBAH LONGWALL PERFORMANCE TREND

Implement as you learn, so the indicators are moving……

Moranbah North Mine 2012 - 2013
Average Weekly Hrs and Cut rate per Month
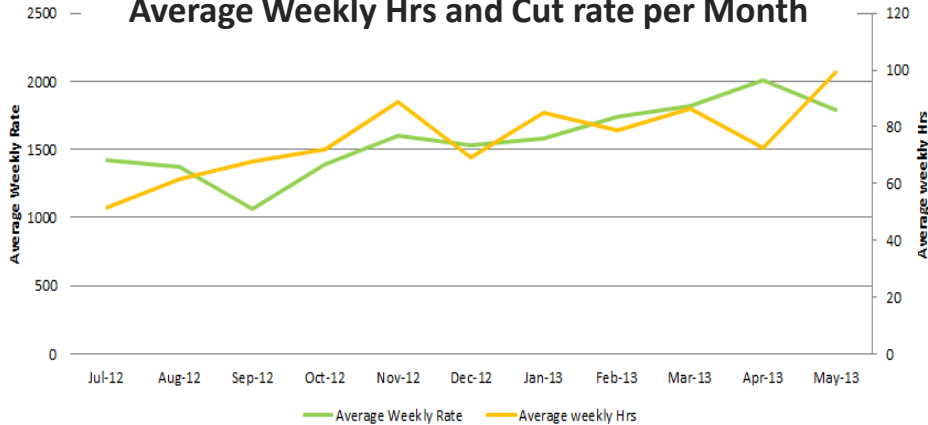
Average Weekly Tonnes

CRITICAL CONTROL PARAMETER IMPROVEMENTS	JUL 2012 TO SEPT 2012	DEC 2012 TO JAN 2013	% CHANGE
Automation Usage Percentage	29.9	70.7	136 %
Pan face alignment articulation angle (degrees)	0.23	0.20	-11 %
Shearer heading angle per shear (degrees)	1.5	1.2	-21 %
Pan pitch angle (degrees)	2.1	1.6	-23 %
Roll - pan articulation (degrees)	0.21	0.15	-27 %
Shearer roll angle (degrees)	2.7	2.1	-22 %

Smart Services provides the analysis and predicts the issues before they occur

VALUE THROUGH REPLICATION

Apply the learnings to the next four Longwall Mines in project phase ….

- We understand the design changes required to improve reliability to benchmark and are implementing them at our current operations

- We appreciate the design changes to achieve higher cutting rates and are implementing them at Moranbah North Mine

- We are designing Grosvenor Mine and the rest of the UG expansion program as a replication of this new knowledge

- We will embed the process of improvement in design and build programme to learn:
  - From current operations
  - From projects being implemented
  - From others that do it well

We will continue the improvement journey as a primary systematic process in the organisation

THANK YOU