The Business Leaders Dilemma

A Bird in the Hand or Two in the Bush

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The Two Options for Business Improvement are Based on Different Principles

Continuous Improvement

(Stabilise the Assets)

- Stabilise process by standardising procedures and training staff
- Identify and remove special causes of variation
- Utilise the better work and materials flows to increase capacity and/or eliminate waste
- Identify and remove common causes of variation

Enhance the Technology

(Change the Assets)

- R&D to establish an alternative process
- Select technology and address any changes with suppliers or customers
- Design and construct the new process or equipment
- Document procedures and train staff in the new process and its control
- Commission

Both options require a systematic approach, innovative thinking, technical understanding, and dedication to see the idea through to reality

The Drivers of Improvement are Quite Different

Continuous Improvement	Enhance the Technology
Stable	Robust
Consistent	Most Efficient
Integrated	Biggest
Timely	Flexible
Measured	Automated
Simple	Complex
Lean	Room to Move
Flowing	Fastest
In Control then Capable	Best in Class then in Control

Both aim to be safest, lowest capex, lowest opex, most efficient, least environmental impact, etc

Ultimately, Both Approaches are Reliant on the Other

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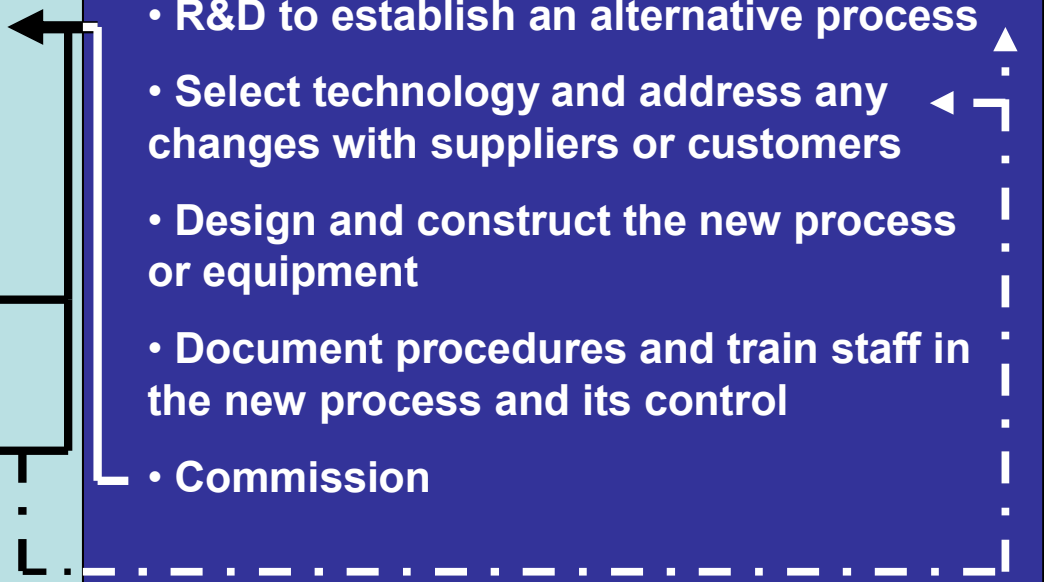
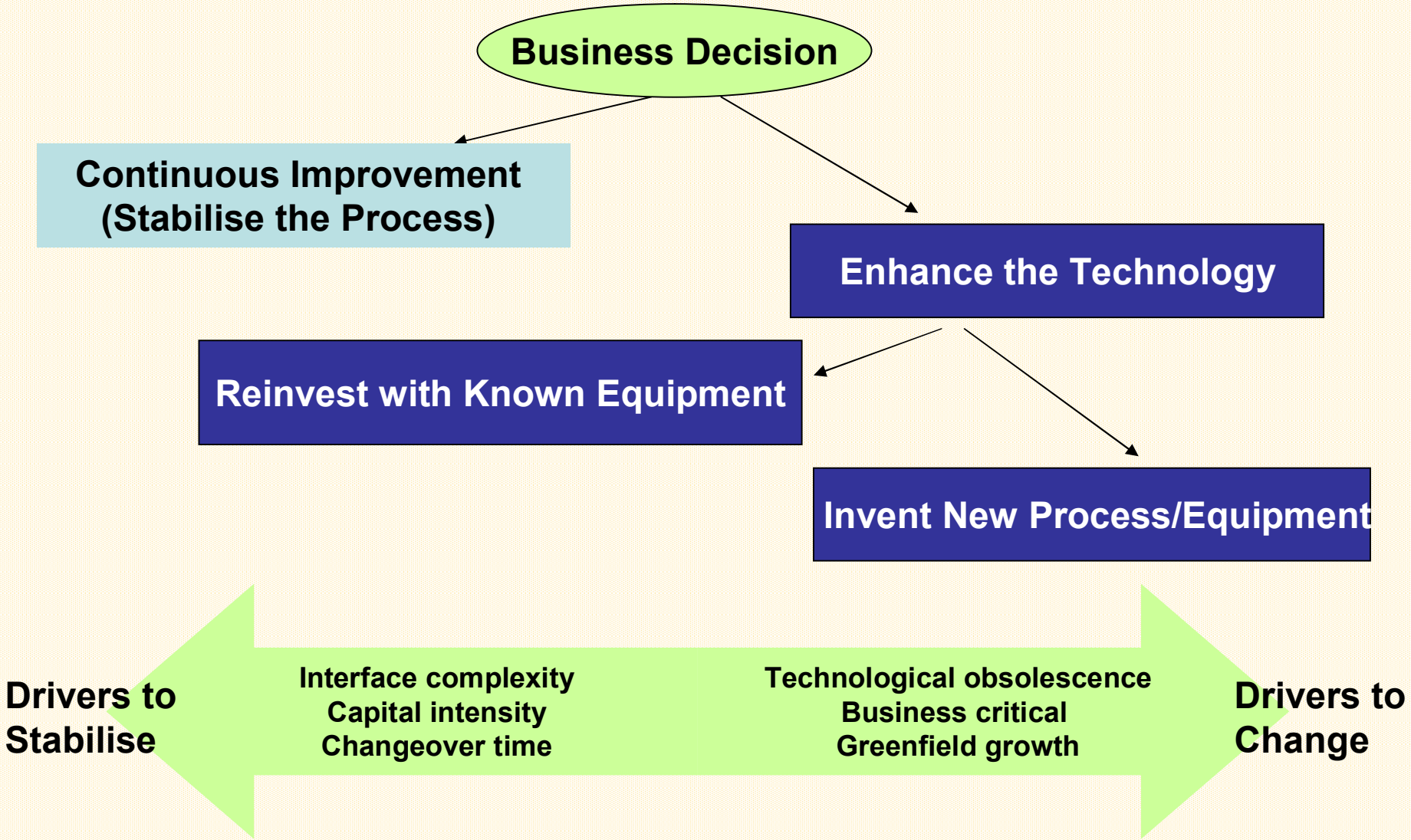


Where should one start the improvement journey?

The Hierarchy of Choice



The Hierarchy of Choice – A Personal Example

Business Decision
(1992)

Aluminium smelter, 35 years old, 90 ktpa, 90kA, 10 year power contract, 1200 people

Strategic Options Available at the Time

Continuous Improvement	Updated Technology	Revolutionise Aluminium
$100m capex to improve HSE	$1b capex for new potline	$150m capex to improve HSE and *prototype* low energy cathodes
Focus on minimising variation • reduced labour costs • improved power efficiency • greater throughput/pot • niche product mix	Extend power contract and operate to industry standards • reduced labour cost • improved power efficiency • greater throughput/pot	Staged changeover technology • 25% better power efficiency • greater throughput/pot

Equivalent decisions face managers at all levels of companies, relating specifically to the assets within their control

Measures for Decisionmaking are Well Established

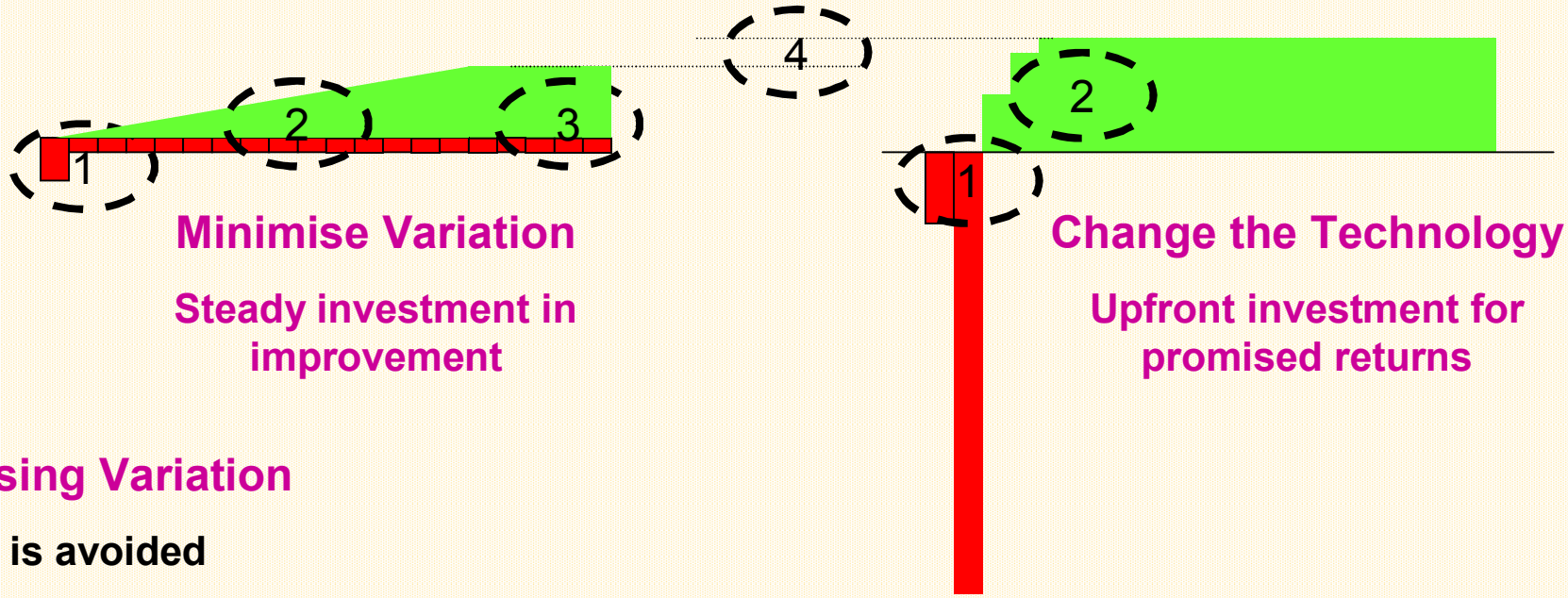
	Strengths	Weaknesses
NPV and IRR	Enables judgements between different revenue, capital and operating cost profiles.	Critically dependant on assumptions Under-rates the option value of competitive assets
Risk	Sensitivities to technical and financial uncertainties can be modelled Known risks can be managed	Perception of risk is highly dependant on the experience of the assessor

Understanding the impact of assumptions on financial models helps decisionmaking,

Understanding risks offers the basis for project management.

But the Resulting Answers are Rarely Black or White.

The Cash Flow Profiles of The Two Improvement Methods are Very Different



Minimise Variation

Steady investment in improvement

Change the Technology

Upfront investment for promised returns

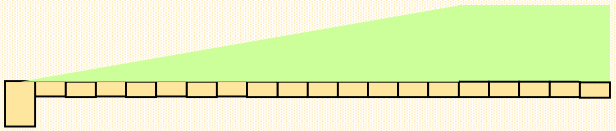
If Minimising Variation

1. **Capex is avoided**
2. **Benefits accumulate steadily**
3. **Continuous improvement meets apparent limits (requiring change in focus, or innovation to circumvent the barrier)**
4. **Technological change will ultimately surpass the capability of the original asset**

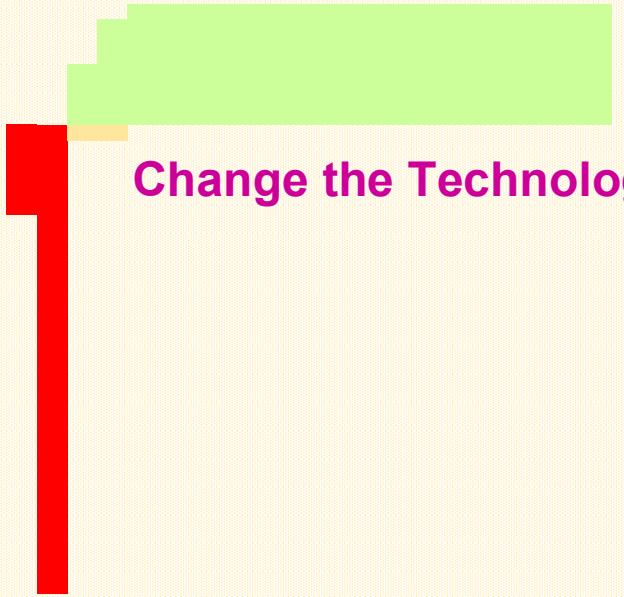
Any improvement rate is limited by the ability to implement each change effectively, without losing overall control – too much change is dangerous

The Risk Profiles are Also Very Different

Risk is the product of the total investment ($) and the probability of failure (in part or total) to reach the objective



Minimise Variation



Change the Technology

All improvement pathways have risks which to be managed effectively

- **Doing the right work (scoping),**
- **Doing the work right (project management)**
- **Harvesting the benefits (ramp up)**

The relative rates of improvement dictate the timing to introduce new technology

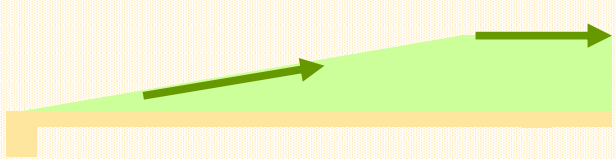
Characteristics of Mining and Metals Industry

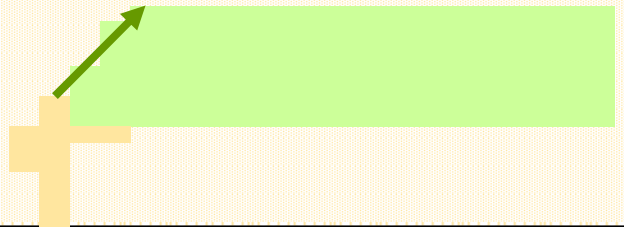
- **Capital intensive**
- **Steady gains in measurement and control**
- **Long life fixed assets with few revolutions in technology**

Modest spending on R&D is a defacto recognition that minimising process variation is usually a 'better bet' than re-inventing the process.

However, failure to re-invest in new technology leads to stagnation and inevitable decline of a business

The essence of leadership judgement, is knowing how much more can be extracted from the existing assets – when is it time to change?





What is the Historical rate of Continuous Improvement, and Where are the Constraints?

Internal Benchmarking (utilising lean manufacturing / six sigma principles)

- Are the critical processes identified and 'in control'?
- What is rate of inventory variation and where is it located?
- Can waste be eliminated from the work-flow?
- What is the best short term performance, and how can it be sustained?

External Benchmarking (competitors and suppliers)

- What do others achieve with similar processes and equipment?
- How do they structure their work-flows differently?

Theoretical Limits Analysis

- Are the constraints to throughput / efficiency / recovery a technical limit?
- If this constraint were overcome, where is the next constraint in the system?

All Improvements are Underpinned by Technical Understanding

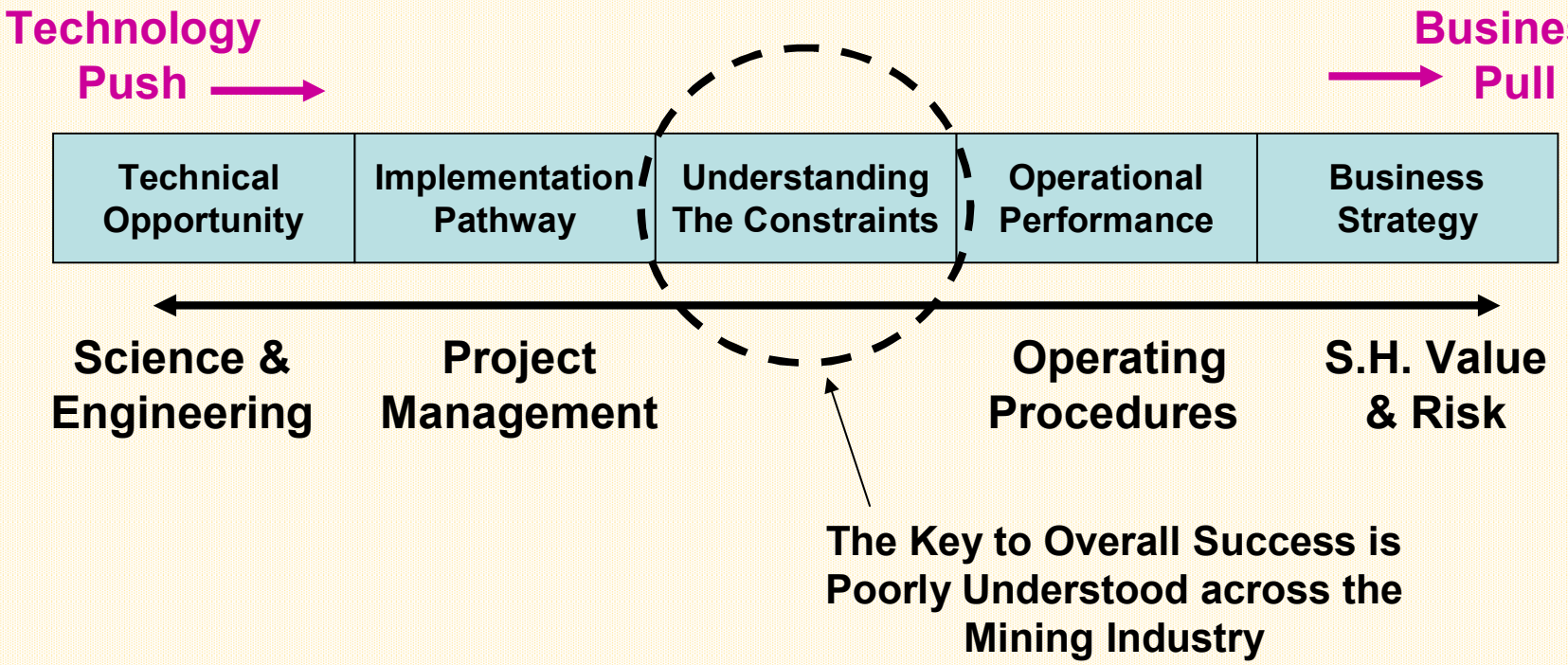
Continuous Improvement (Measurement and Control)

- Develop and establish measurement and data management systems with the timeliness and precision necessary to control the system
- Understand each interdependent process variable, and optimise the overall system within the constraints of each process
- Model the system to establish cause and effect

Enhance Technology (Simulation and Innovation)

- Understand the limits of the new process and equipment, to ensure its applicability to the particular opportunity
- Understand the impact of change on the interfaces, to reduce the risk of inadvertent impact elsewhere in the system
- Undertake stretching R&D, to achieve a performance sufficient to justify the risk of implementation in a capital intensive industry

Alignment is Necessary Across Multiple Languages



Hypothesis

A clear connection between technical opportunity and business strategy, built on a thorough understanding of the constraints, will enhance the rate of business improvement greatly

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Checklist for an Improvement Project Leader (DMAIC)

Define

- Which is the bottleneck or leverage point that requires improvement now?
- Are the necessary gains quantified using both technical and financial measures?
- Can the root causes of the issue be eliminated, or does a technical limit really demand new technology?

Measure

- Are the interface measures (inputs and outputs) well defined?
- Is the measurement system providing the timely, consistent and sufficiently precise data?

Analyse and Improve

- Which root causes of variation be removed, to enhance OEE and remove waste OR how can I ensure the new technology provides a real leap forward, to justify the R&D, capital expenditure, training and documentation, commissioning, and associated risks?)
- Is my project aligned with all stakeholders, planned, gated, and resourced for success?

Control

- Has the basis for good control been established (accountabilities, measurement systems, control and response plans, and audit structure)

The Hierarchy of Choice – A Personal Experience

Business Decision
(1992)

Outcome in 2009

Continuous Improvement	Updated Technology	Invest in R&D
$100m capex to improve HSE	$1b capex for new potline	$150m capex to improve HSE and low energy cathode trials
Focus on removing variation **• reduced labour costs** **• improved power efficiency** **• greater throughput/pot** **• niche product mix**	Extend power contract and operate to industry standards • reduced labour cost • improved power efficiency • greater throughput/pot	Staged changeover technology • 25% better power efficiency • greater throughput/pot
90 to 170 ktpa, **1200 to 600 people,** **92% to 94.5% c.e.** **0.6 to 1.1A/cm2**	**Available and well tested** 170 ktpa, 700 people, c.e. 95%, 0.6A/cm2	Prototype testing in 1992 **R&D still continuing to achieve necessary cathode life**

As an industry, we almost always underestimate the capability of existing assets.

Thank You

With Best Wishes to Mintek for the Next 25 Years