UNDERGROUND OR OPENCUT COAL MINING? WHEN, WHY AND WHAT TOOLS TO UTILSE.

Presented By

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OBJECTIVE

To overview the
"when, why and how" of opencut or underground mining method selection and discuss the issues associated with the decision making process.

THIS PRESENTATION

The when, why and how.

Where Strategic Planning fits in

Comments on our experience

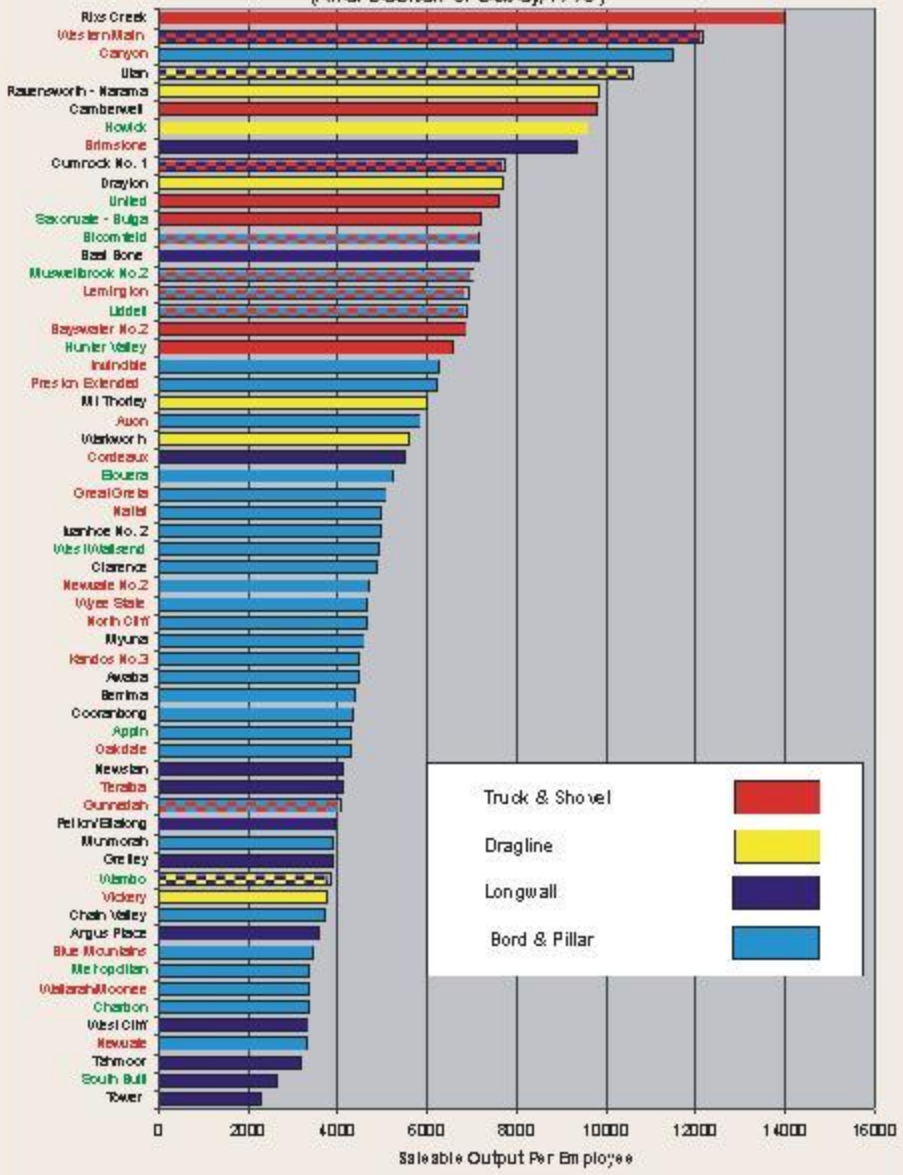
An example based on recent jobs.

WHEN DO YOU DECIDE?

- Greenfields a new geological resource
  - *Mt Arthur North, Saddlers Creek, Ensham*
- Opencut mines with high costs
  - *Moura, Newlands, Muswellbrook, Bulga*
- Underground mine at the end of resource
  - *Liddell, Wambo, Muja, Blair Athol, Rixs Creek, Muswellbrook*
- Factors of timing or market or economics
  - *Technology, Market, Community Standards, Mining Conditions or Ownership*

Productivity for NSW Mines 1991 - 1992

(After Beckett & Casey, 1993)



Productivity for NSW Mines 2002 - 2003

(After Tadros et al, 2004)

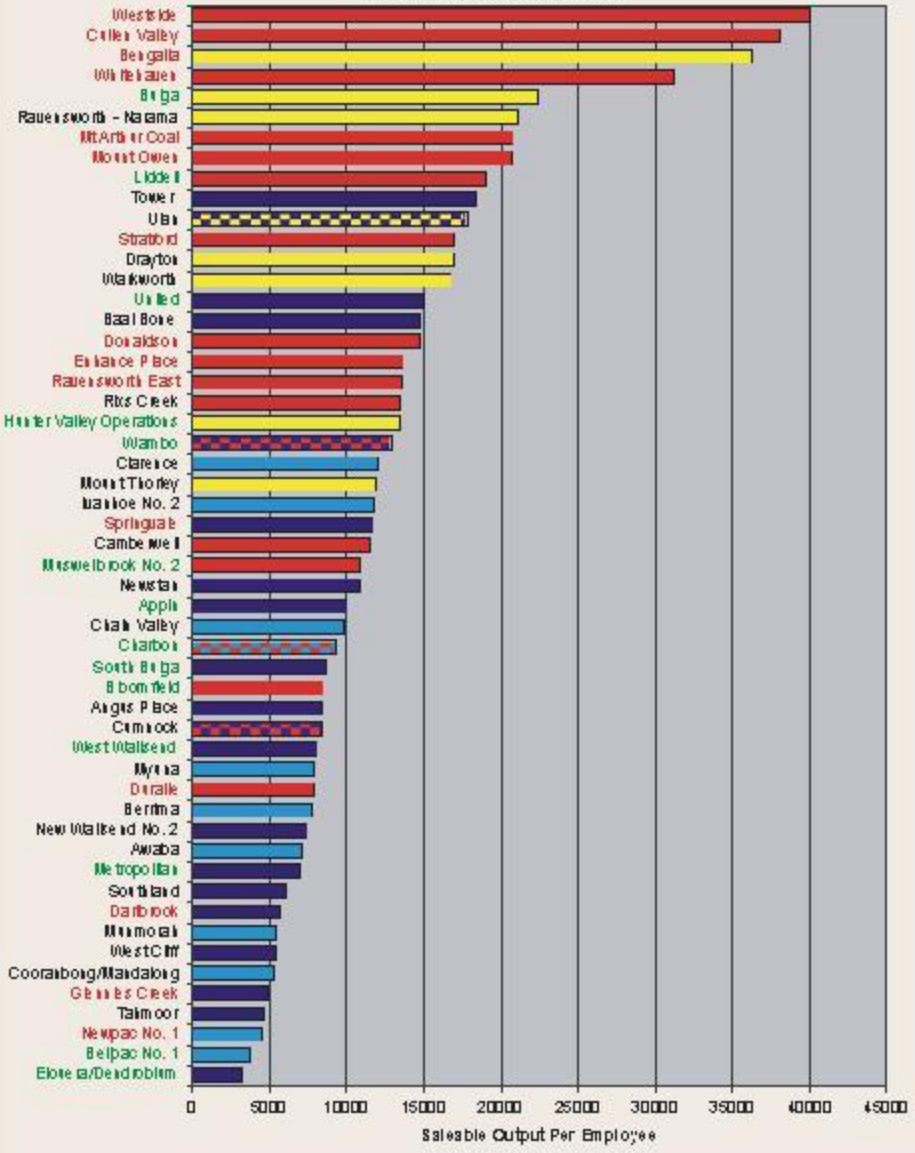
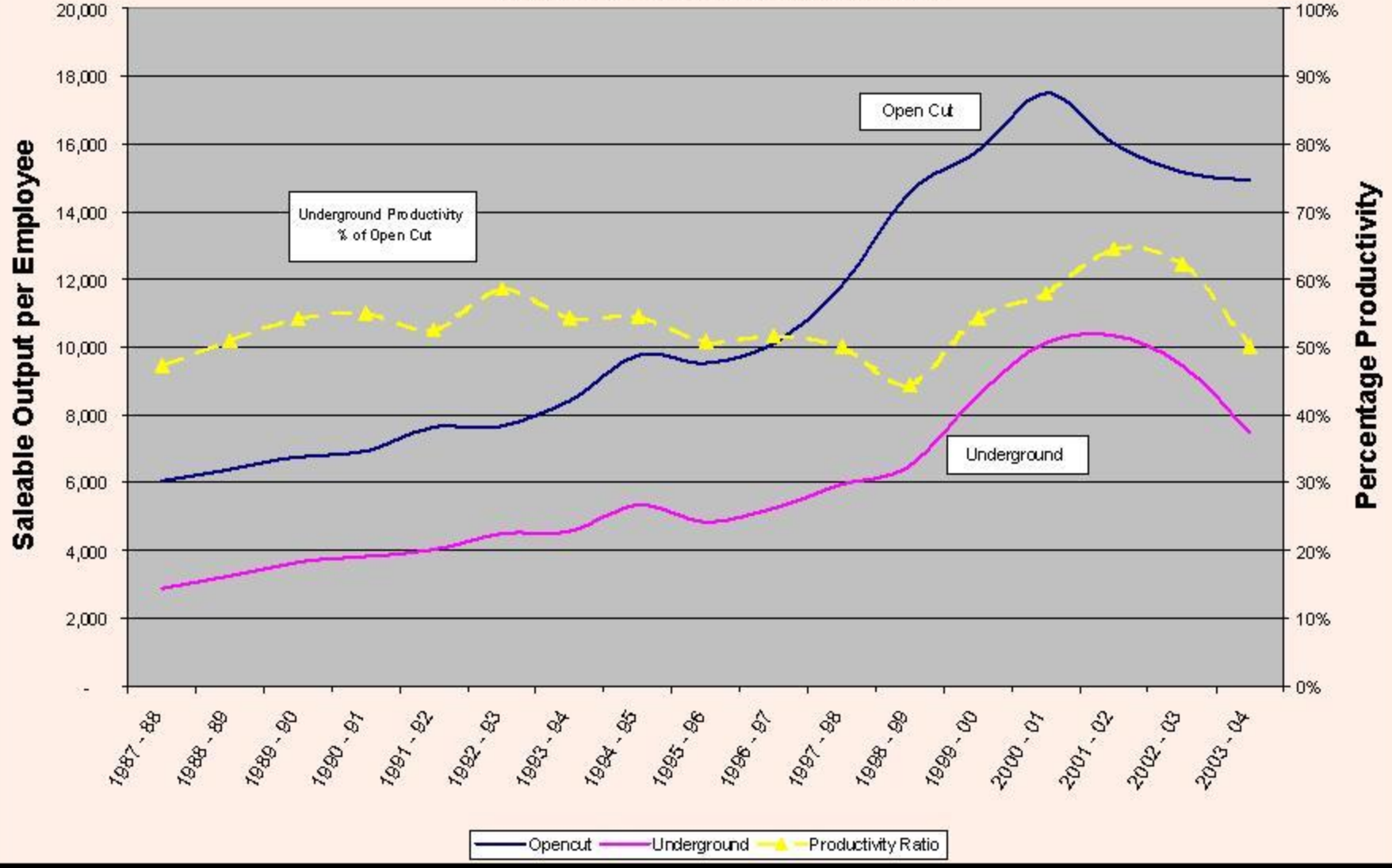


Figure 3 - Output per Employee per Year

(based on NSW DMR Coal Industry Profile and Qld NR&M Statistics



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COMMENTS ON TRENDS

- Most mines have been through a decision process (eg. Mining method, closing down, opening new mines).
- Most mines have shown a substantial increase in productivity and by inference a decrease in cost
- New underground mines have better productivity than the older opencuts
- New open cut mines have better productivity than the new underground mines
- Overall increase in the % of truck shovel operations
- The long term relativity of the mines is consistent at approx 50-60% over the period.

SUMMARY

- There is continuous change
- UG and OC are both changing at a similar pace
- Long term increases in productivity needs to be included in Strategic Mine Planning
- The plan should be reviewed frequently

WHY DECIDE?

- Not just a cost decision
- Complex interplay of factors
- We contend the decision whether to mine by underground or opencut methods, is part of a *strategic planning process*.

WHAT IS STATEGIC PLANNING?

It can be defined

"as the continuous creation of real value and competitive advantage".

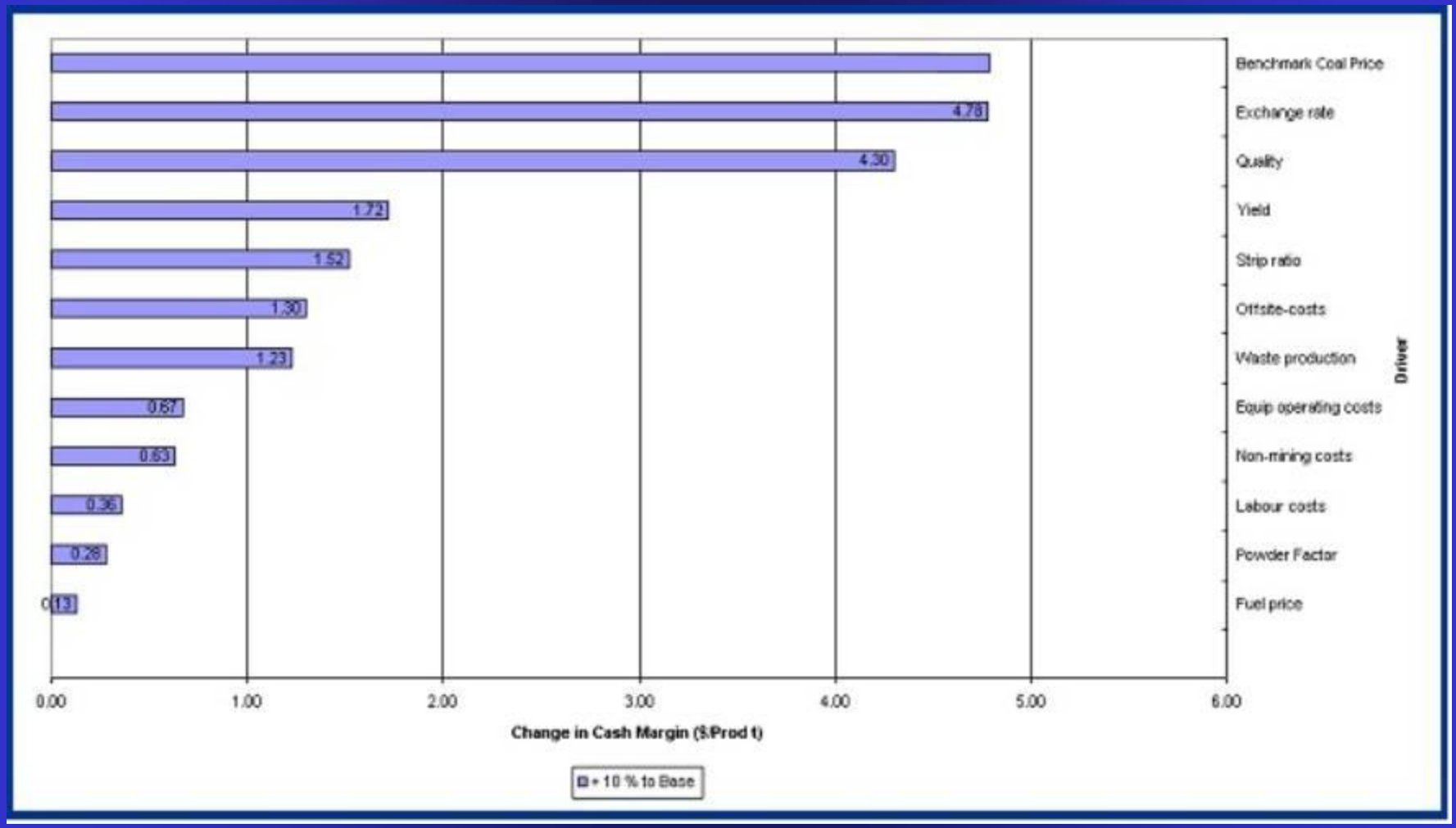
BUSINESS DECISION

- Who makes the decision - Business!
- What is the purpose of Business
  - **to maximise stakeholder value**
- How does it do this?
- By undertaking Strategic Planning.

FACTORS

- Some factors that influence the decision
  - Strategic
  - Resource
  - Market
  - Product mix
  - Risk
  - Geology
  - Environment
  - Financial
  - New Management

WHY A STRATEGIC DECISION?



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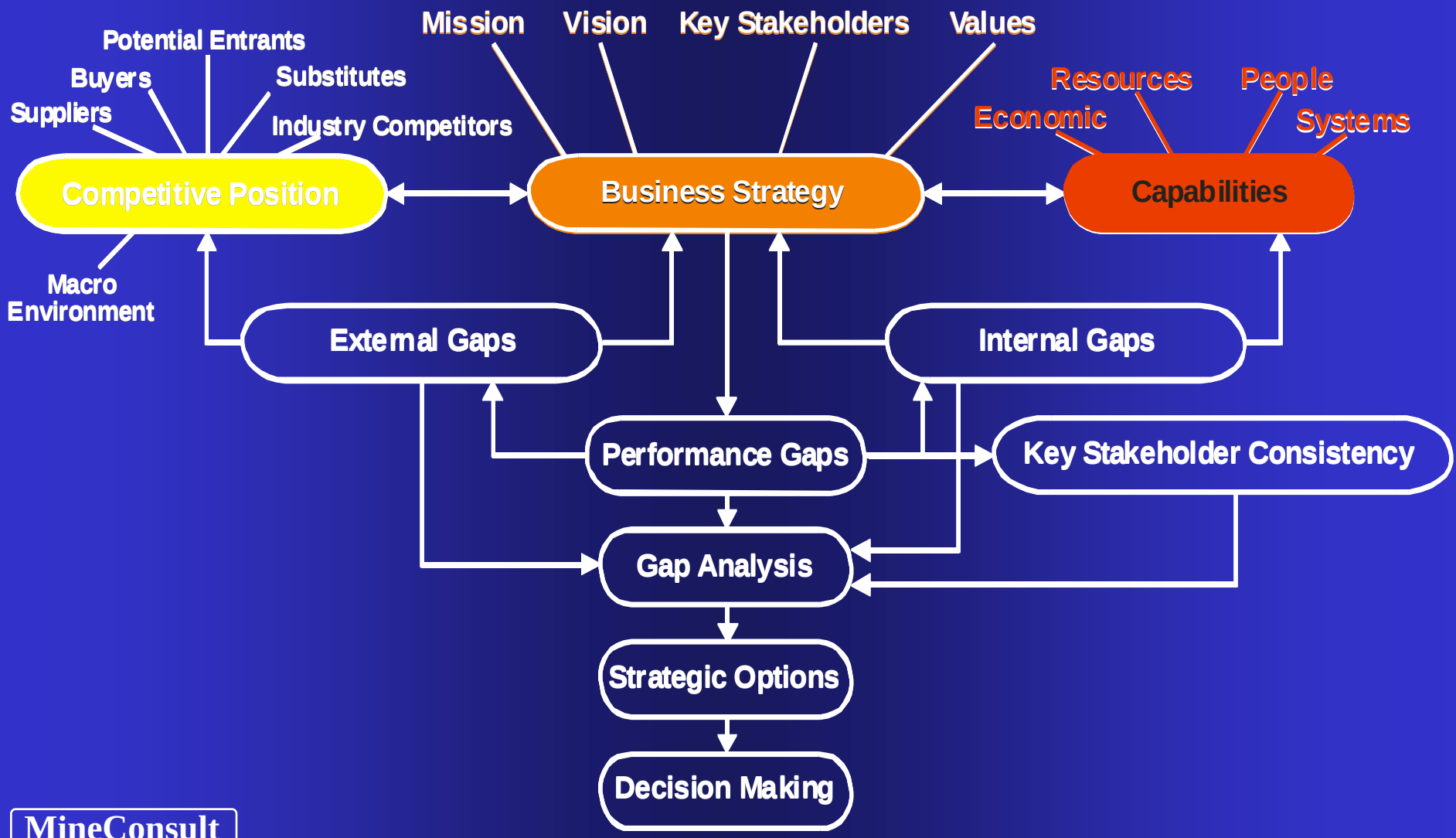
CONCLUSION

- Why does a business look at options regarding opencut or underground mining?
- To achieve the purpose of the business, to increase the value and competitive advantage to the stakeholders
- It does this by *strategic planning*

STRATEGIC DECISION MAKING MODEL



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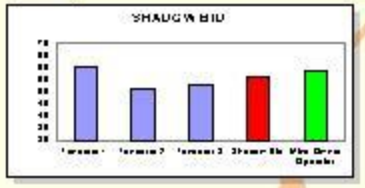
HOW - WHAT TOOLS TO USE?

- There are many commercial planning tools available for opencut and underground
- They can readily be adapted to suit most projects
- The time taken to do a strategic option is quite short (low cost)
- We recognise the challenge to improve our process to present more than only the “economic value” methods

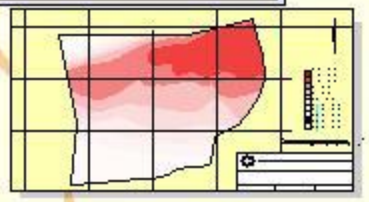
COMMERCIALTOOLS

SOME TOOLS IN USE

Shadow Bid



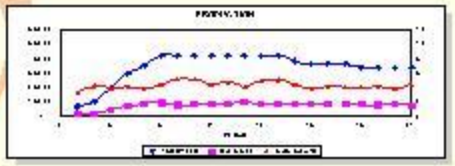
Economic Ratio / Profit Model



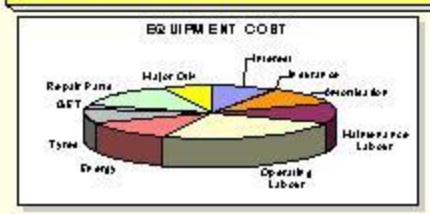
The MiMaSo inhouse software is combined with commercial Mining Software to best fit the Project.

Economic Modelling

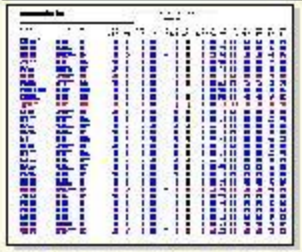
Production Schedule



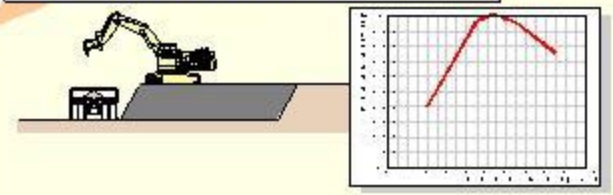
Equipment Cost



Database

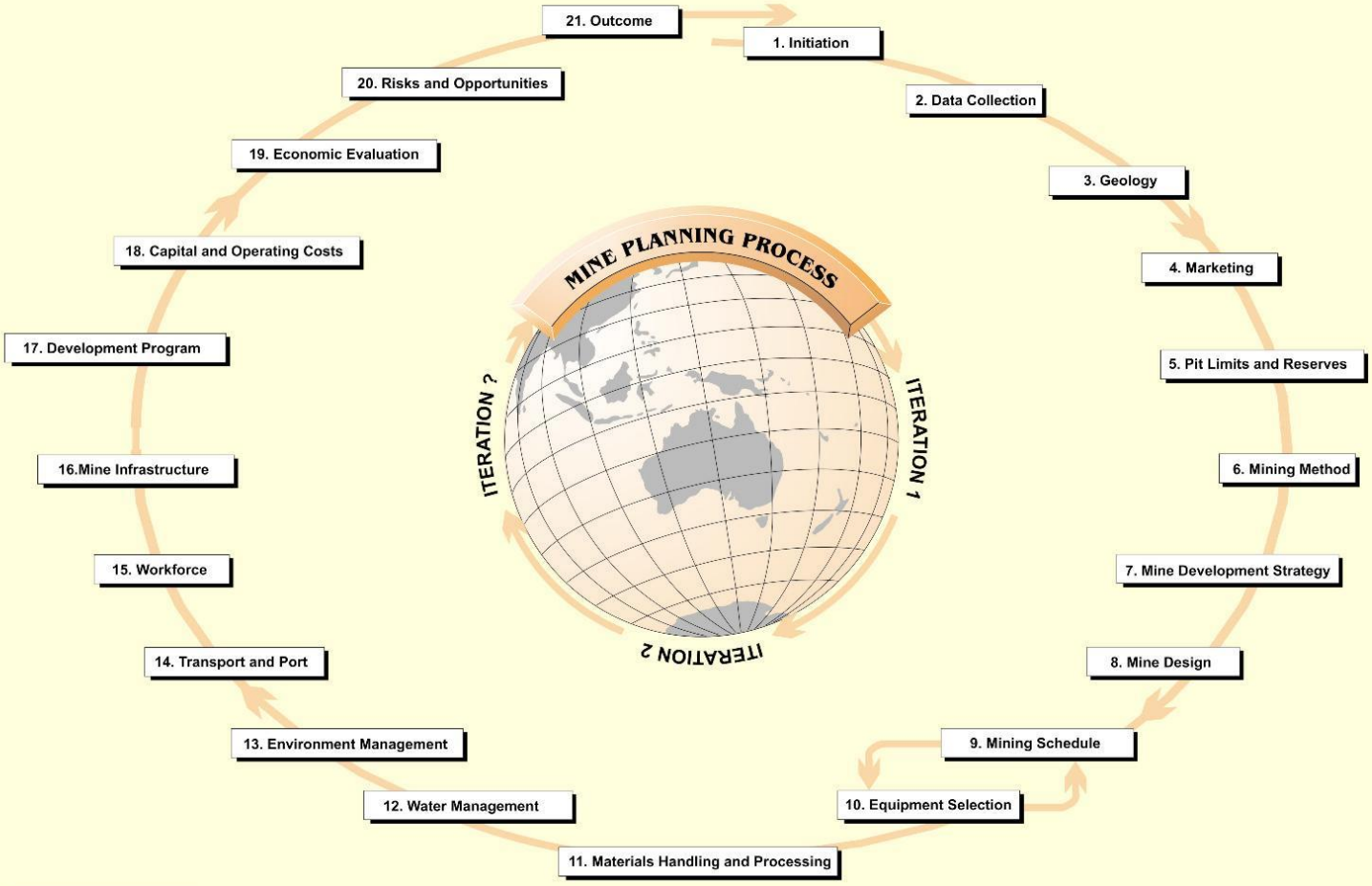


Equipment Productivity



MINE MANAGEMENT SOFTWARE (MiMaSo)
OUTPUT EXAMPLES

STRATEGIC MINE PLANNING



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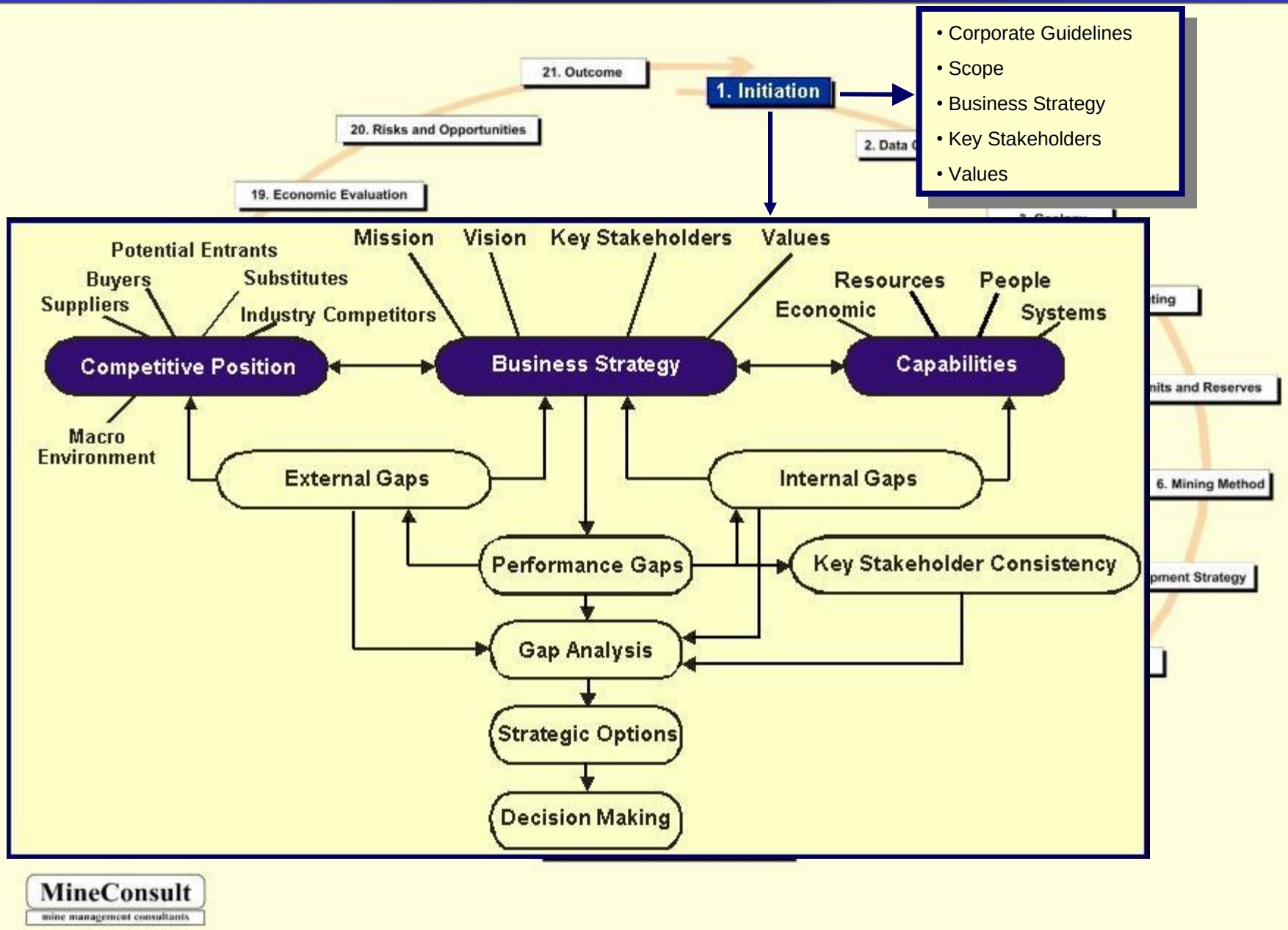

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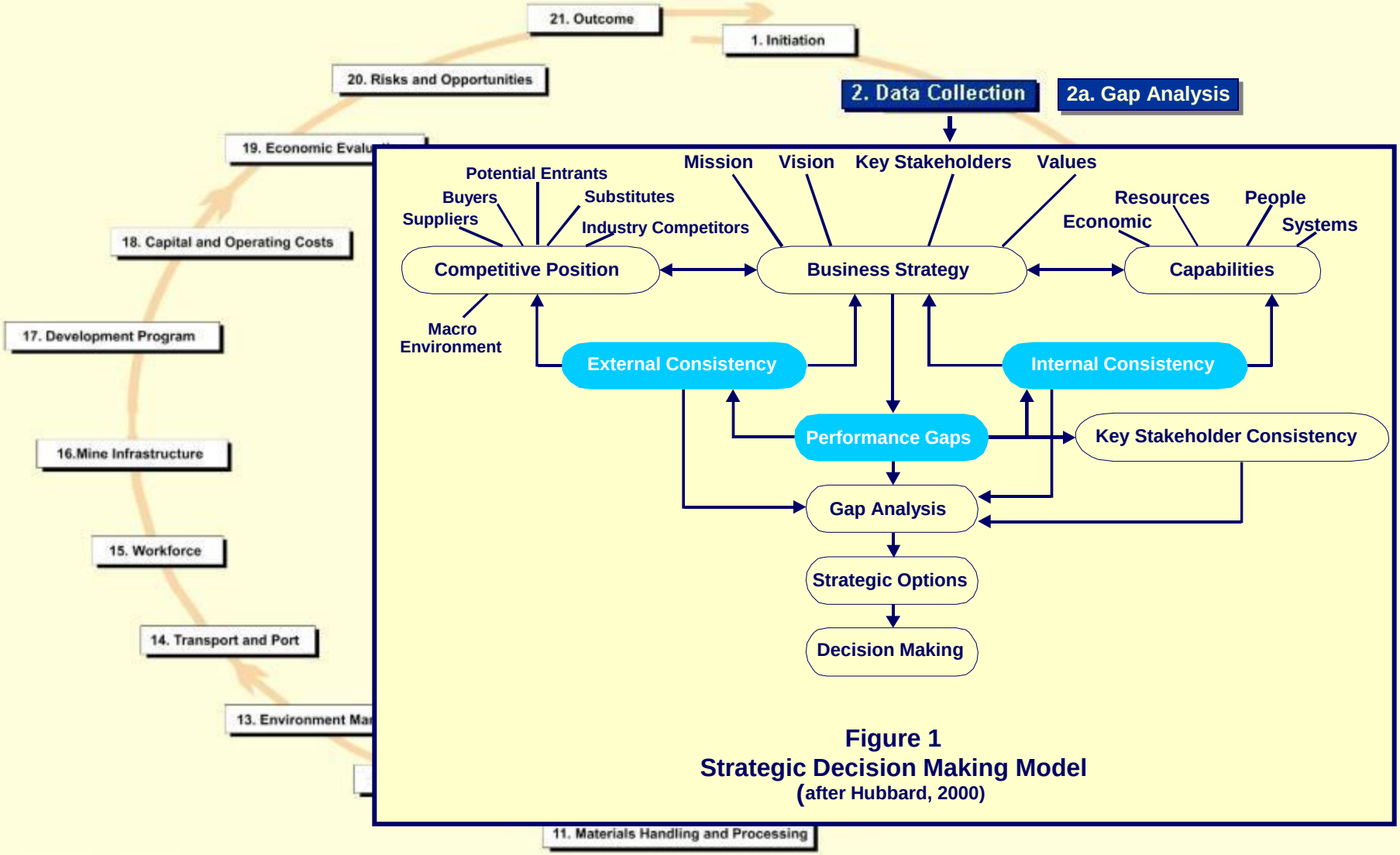

Figure 1
Strategic Decision Making Model
(after Hubbard, 2000)

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21. Outcome

1. Initiation

20. Risks and Opportunities

2. Data Collection

2b. Key Drivers

19. Economic Evaluation

• Current Position

3. Geology

18.

4. Marketing

17. Development P

5. Pit Limits and Reserves

16.Mine Infras

6. Mining Method

15. W

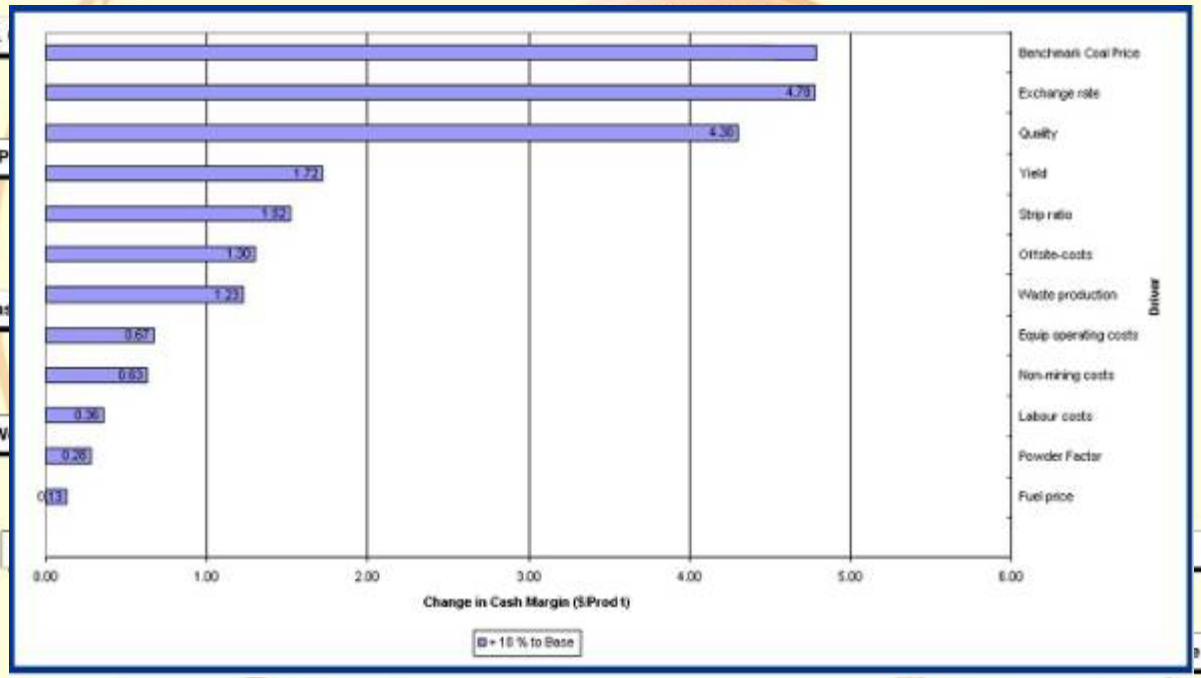
7. Mine Development Strategy

8. Mine Design

12. Water Management

10. Equipment Selection

11. Materials Handling and Processing



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21. Outcome

1. Initiation

20. Risks and Opportunities

2. Data Collection

19. Economic Evaluation

3. Geology

3a. Working Section

18. Capital and Operating Costs

4. Marketing

17. Development Program

5. Pit Limits and Reserves

16.Mine Infrastructure

6. Mining Method

15. Workforce

7. Mine Development Strategy

14. Transport and Port

8. Mine Design

13. Environment Management

Mining Schedule

12. Water Mana

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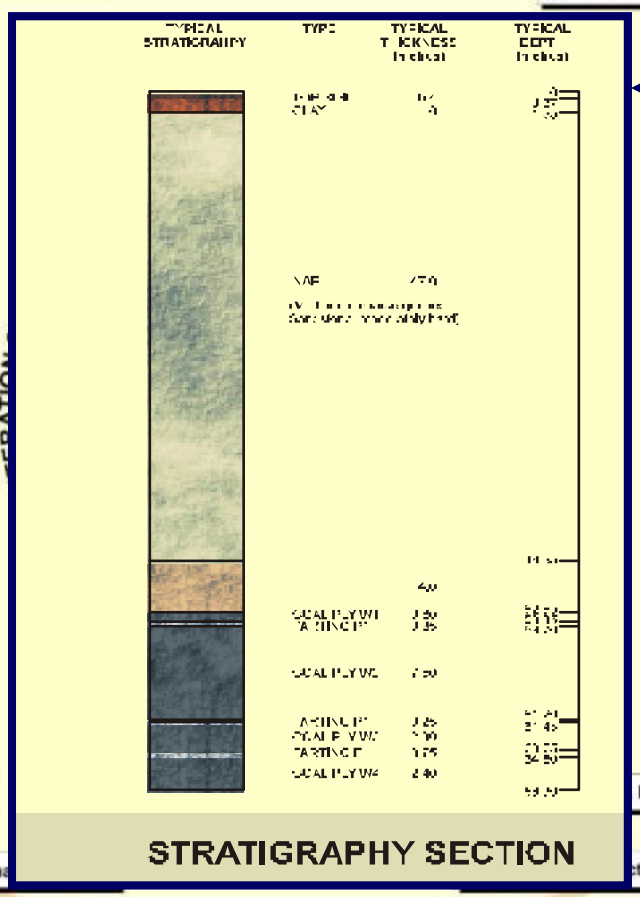
11. Materials Handling and Processing



STRATIGRAPHY SECTION

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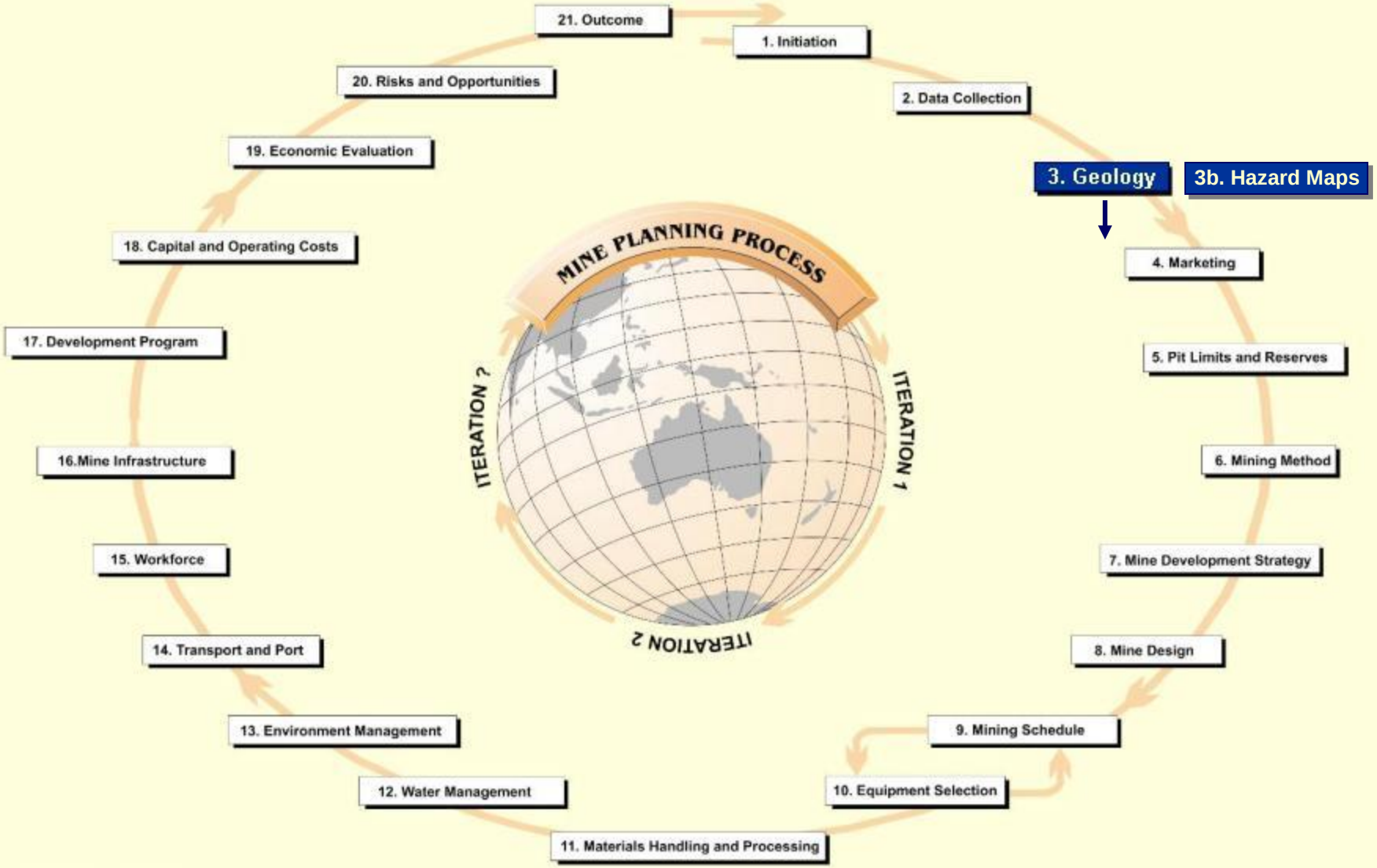

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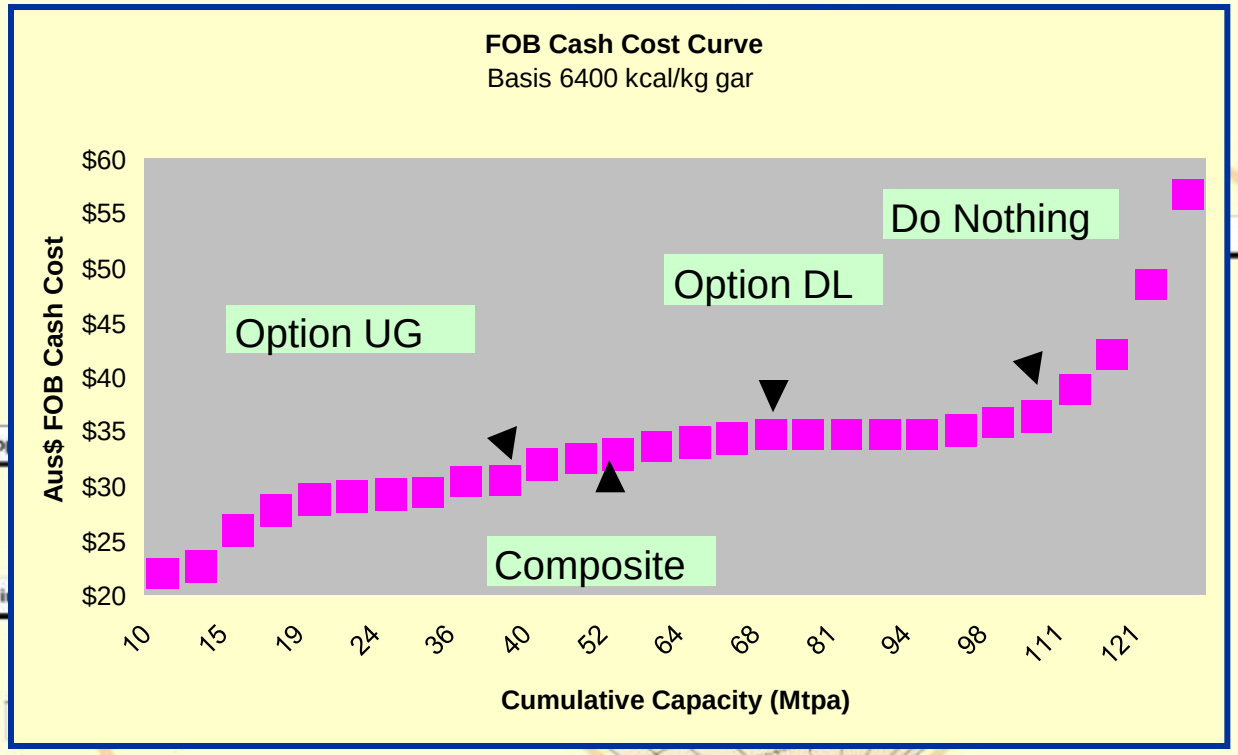

3. Geology

4. Marketing

- Competitive Advantage
- Demand
- Product Specifications

7. Mine Development Strategy

8. Mine Design

9. Mining Schedule

10. Equipment Selection

11. Materials Handling and Processing

12. Water Management

13. Environment Management

14. Transport and Port

ITERATION 2

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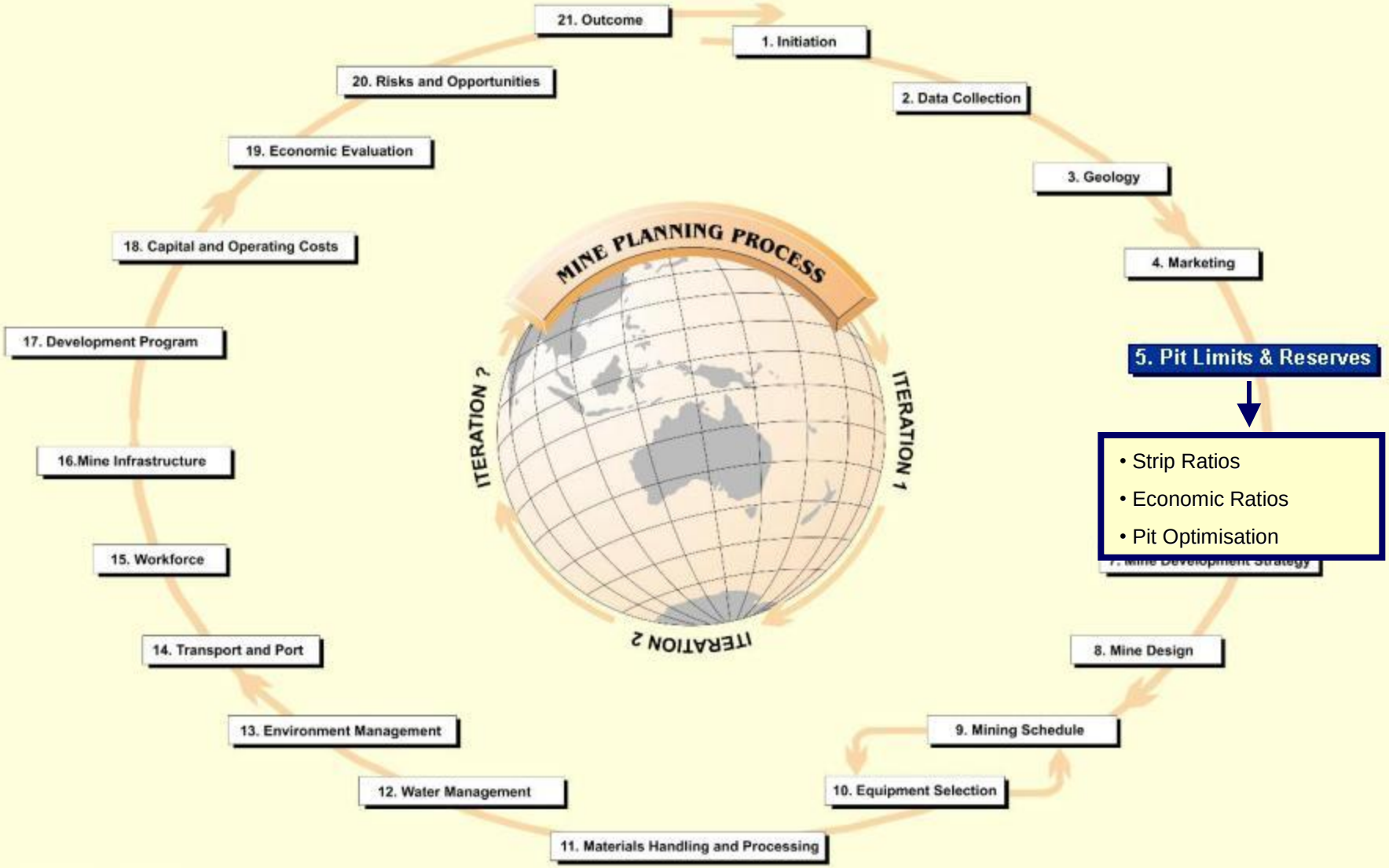

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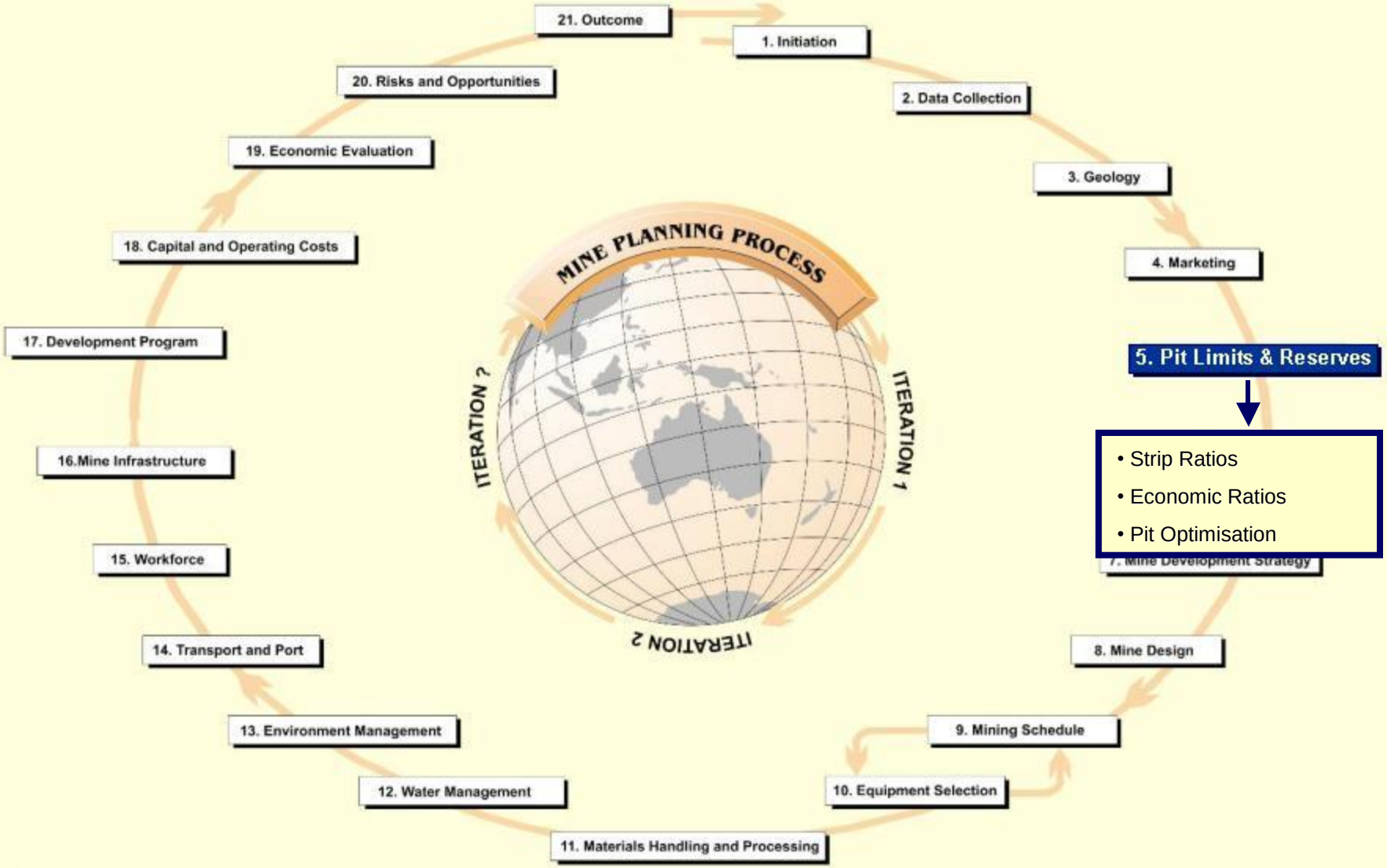

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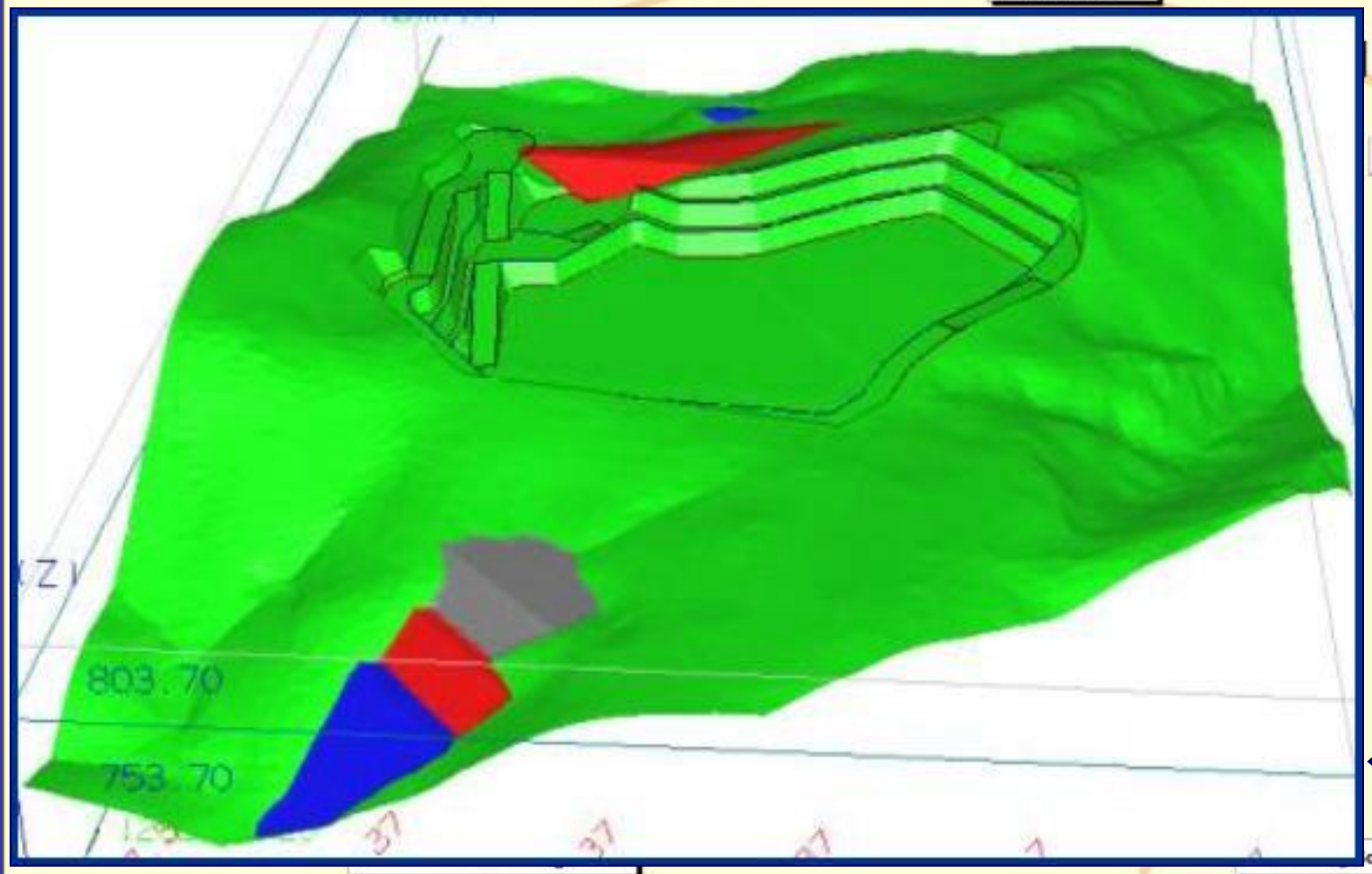

21. Outcome

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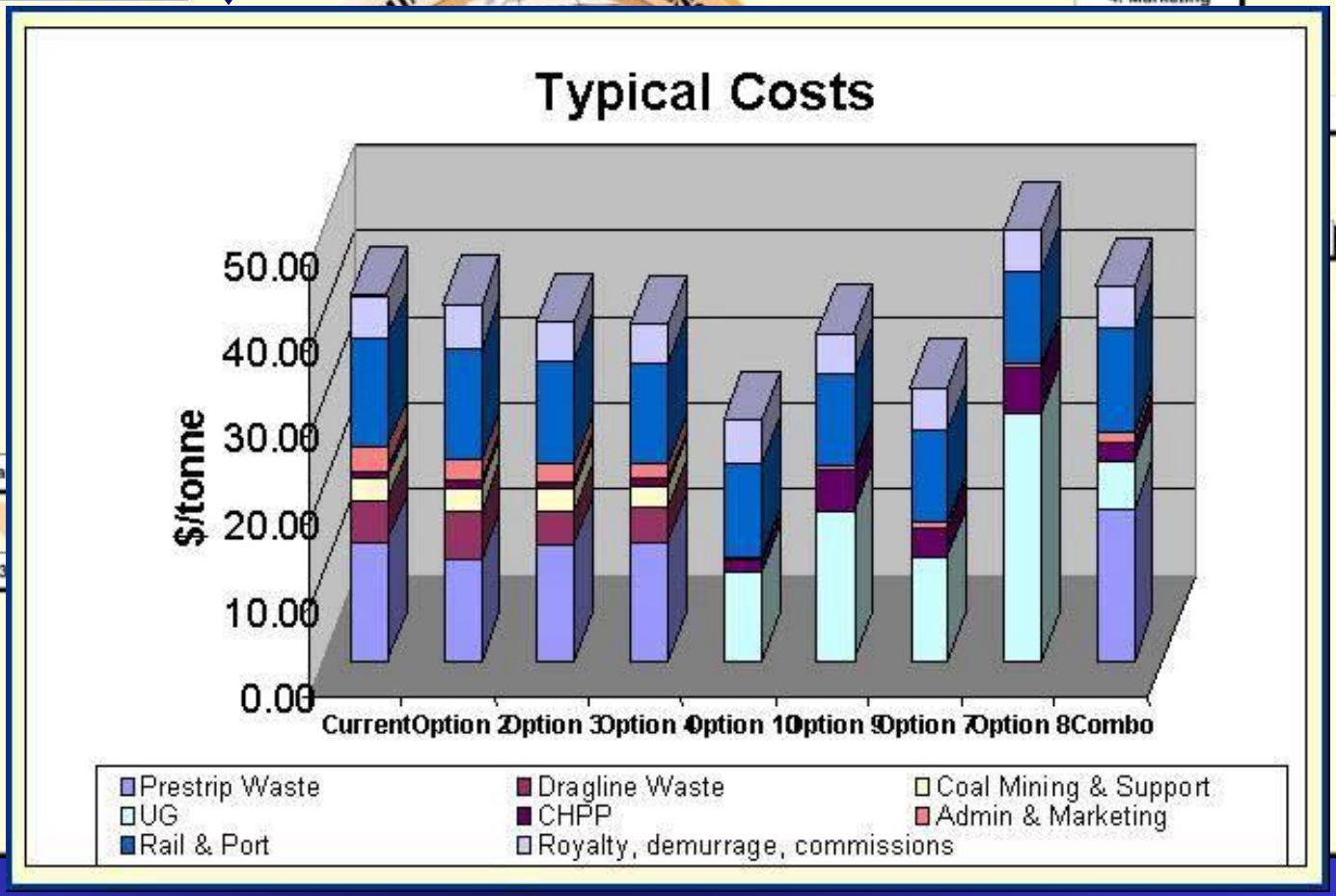
14. Transport a

13



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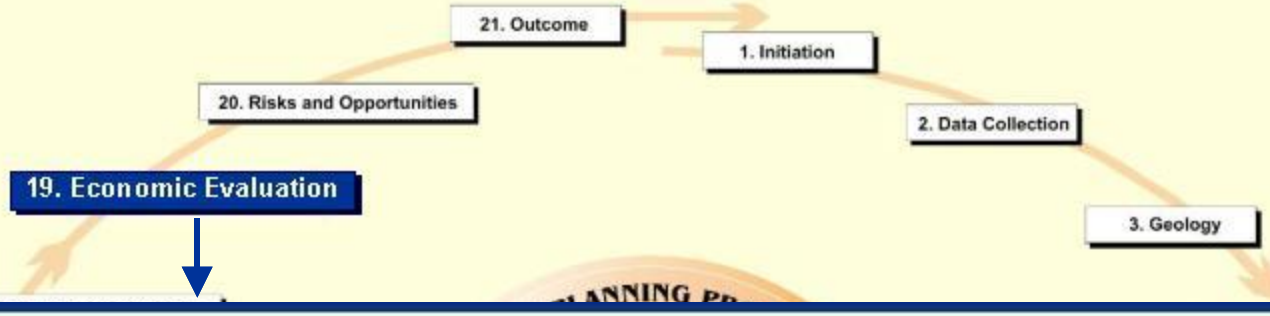

Open Cut and Underground Option Results

Options	Annual Production (Mtpa)	Cumulative NPV (@ 8%) ($M)	Total Capital ($M)	NPV Ratio	Cash Cost ($/Prod t)
Current Case	6.5	350	100	3.5	38.44
Option 1 OC	6.0	86	175	0.5	34.75
Option 2 OC	7.0	370	175	2.1	37.59
Option 3 OC	13.0	800	400	2.0	34.90
Option 4 OC	8.5	630	350	1.7	34.61
Option 6 UG	7.0	83	210	0.4	37.17
Option 7 UG	4.0	27	430	0.0	37.75
Option 8 UG	5.0	-40	100	-0.4	46.09
Option 9 UG	7.5	300	210	1.4	31.84
Option 10 UG	7.0	280	275	1.0	24.80

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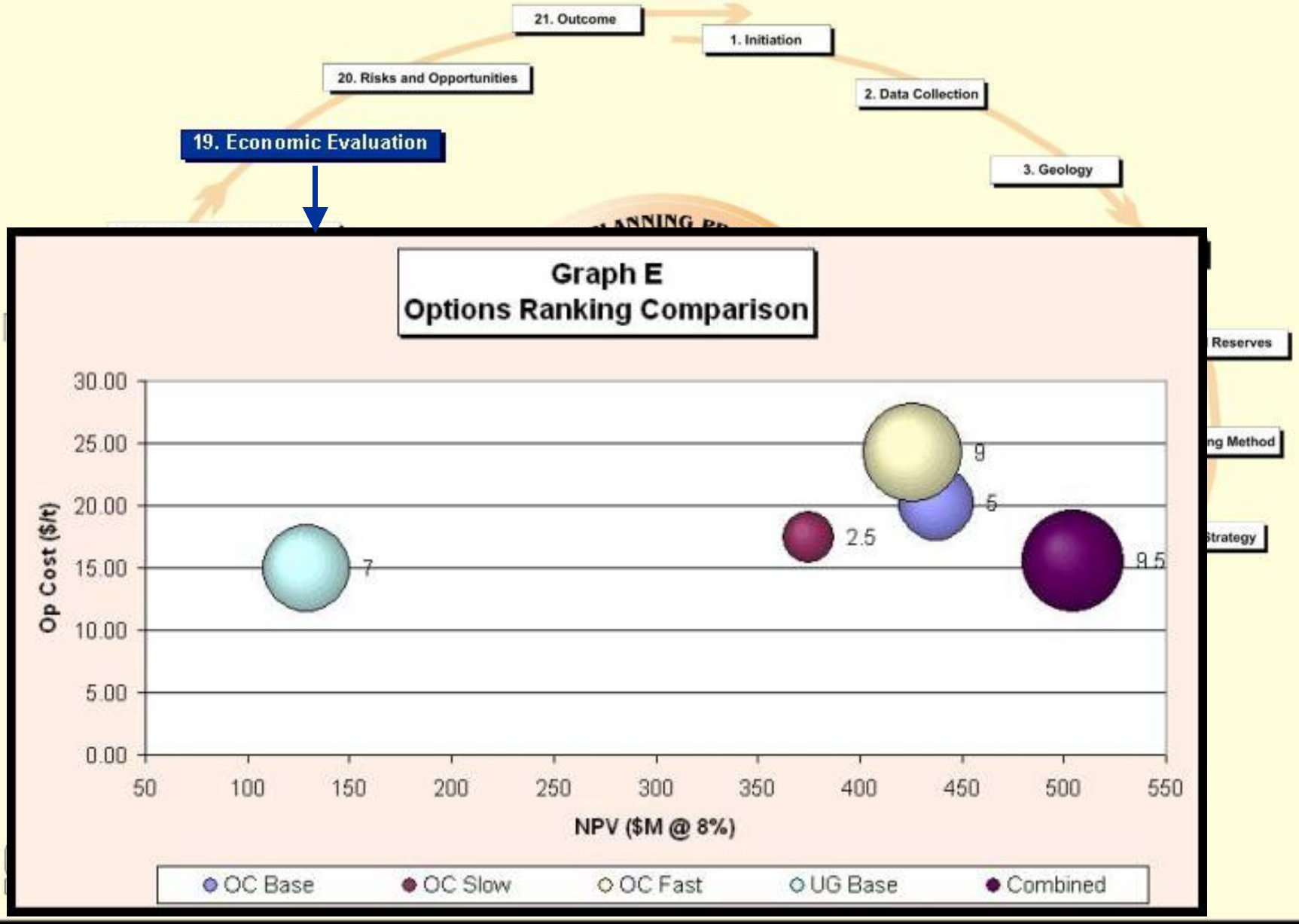
21. Outcome
1. Initiation
20. Risks and Opportunities
2. Data Collection
19. Economic Evaluation
3. Geology
Reserves
ng Method
Strategy
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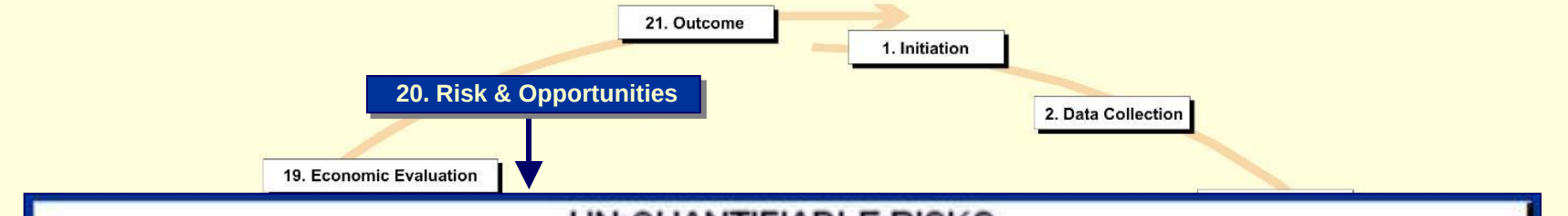
Options Ranking Comparison
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Op Cost ($/t)
50
100
150
200
250
300
350
400
450
500
550
NPV ($M @ 8%)
7
9
5
2.5
9.5
OC Base
OC Slow
OC Fast
UG Base
Combined



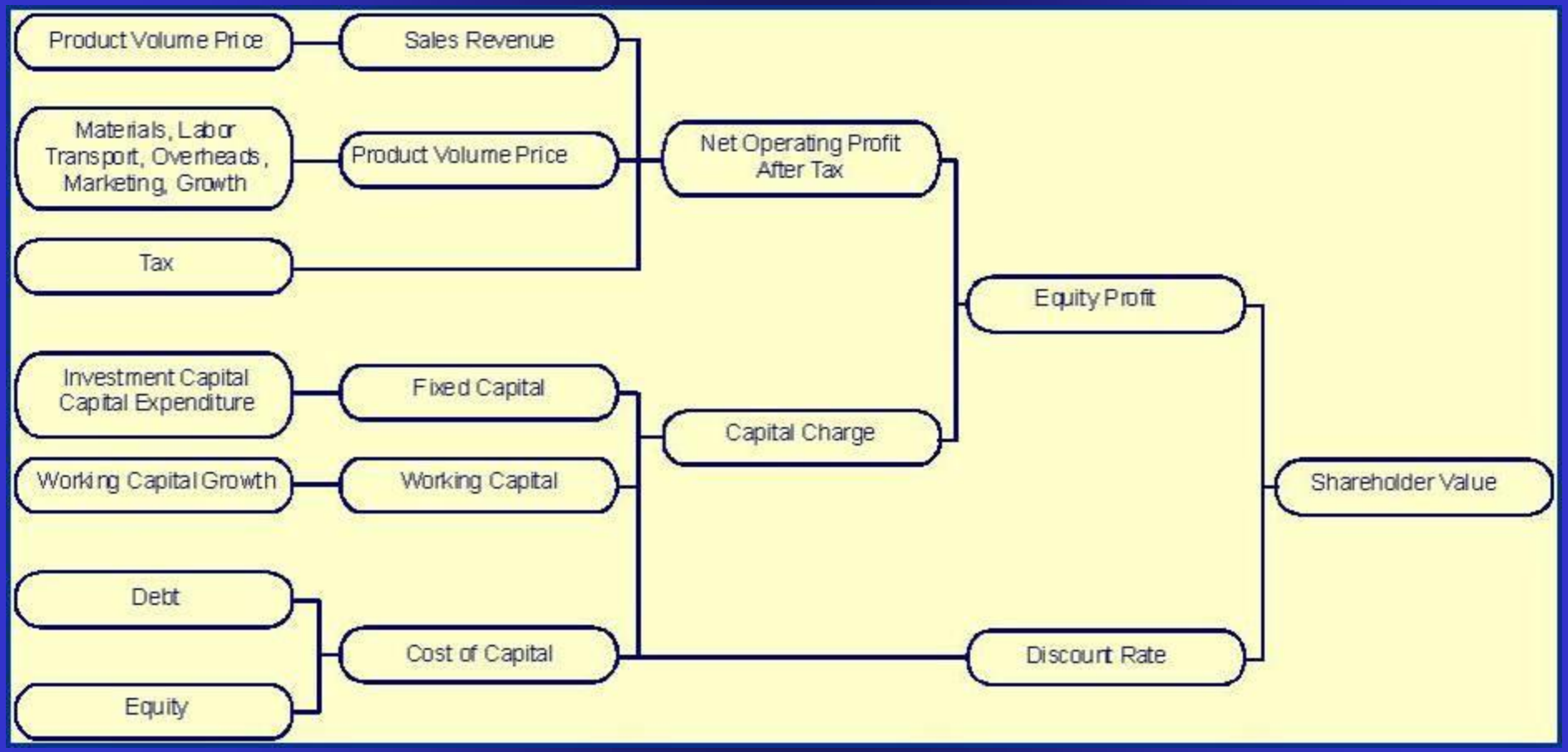
UN-QUANTIFIABLE RISKS

RISK	MINING METHOD		COMMENT
	UG	T/S	
Project Delay			
JV Approval	H	L	Sam reluctance on UG Practicality
Geotechnical	M	M	Spoil stability on steep dips
EIS Modification	L	H	TS may require EIS modification
Delivery & Commisioning	H	L	Lead Time on major equipment
Archaelogical	L	M	Bilbo's Hill - potential issues with Shire folk
Environmental Approvals	H	L	Current modelling data based on T/S option
Ease of Operation	H	M	Includes Adaptability & Group Experience
Scheduling	M	H	Frequent moves, equipment interaction
Other			
Access to U/G Reserves	M	L	T/S gives early UG access UG gives REMNANT access

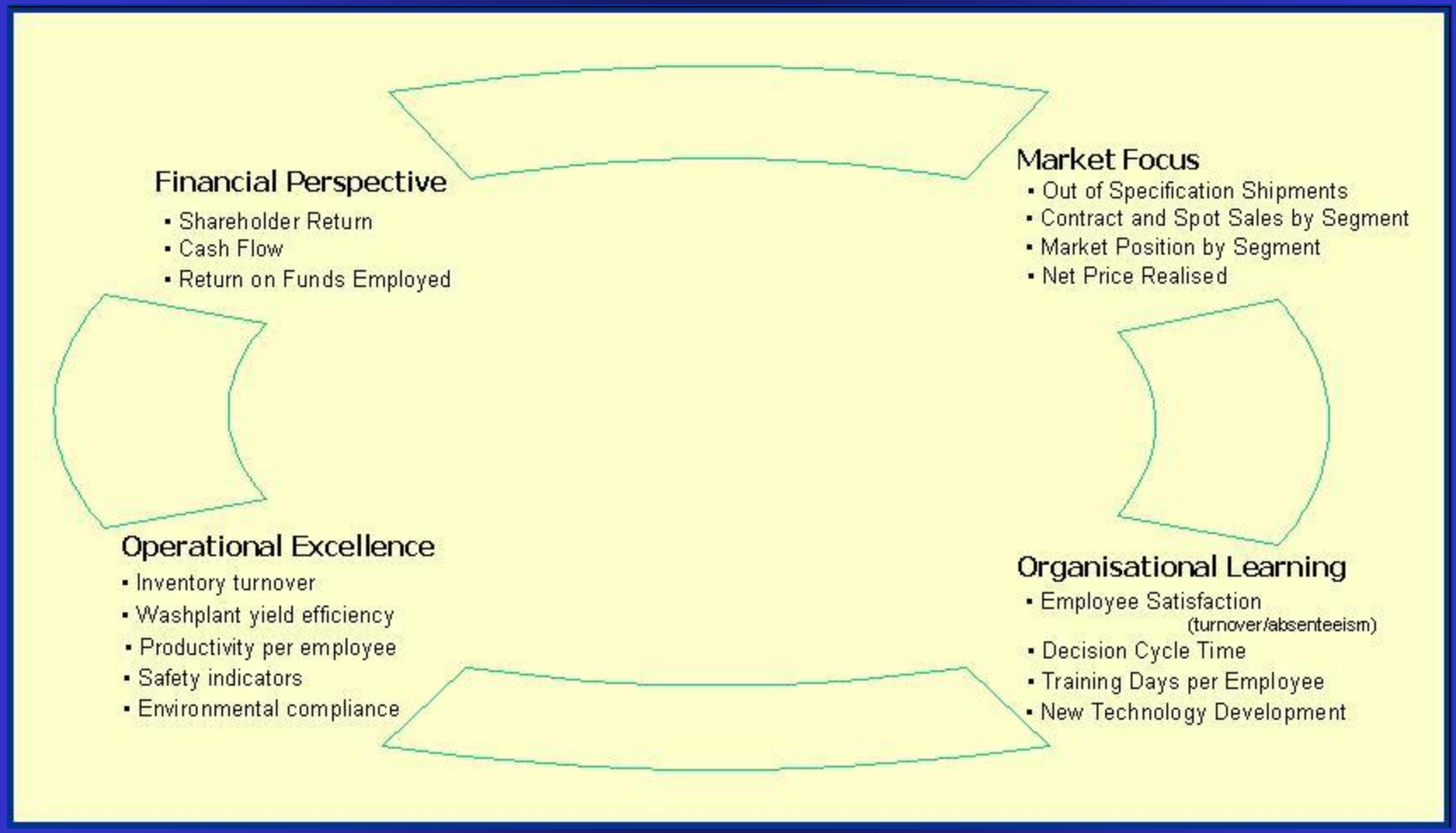
HOW TO DECIDE?

- Two common approaches are used for decision making.
- Shareholder Value or
- Balanced Scorecard

SHAREHOLDER VALUE APPROACH

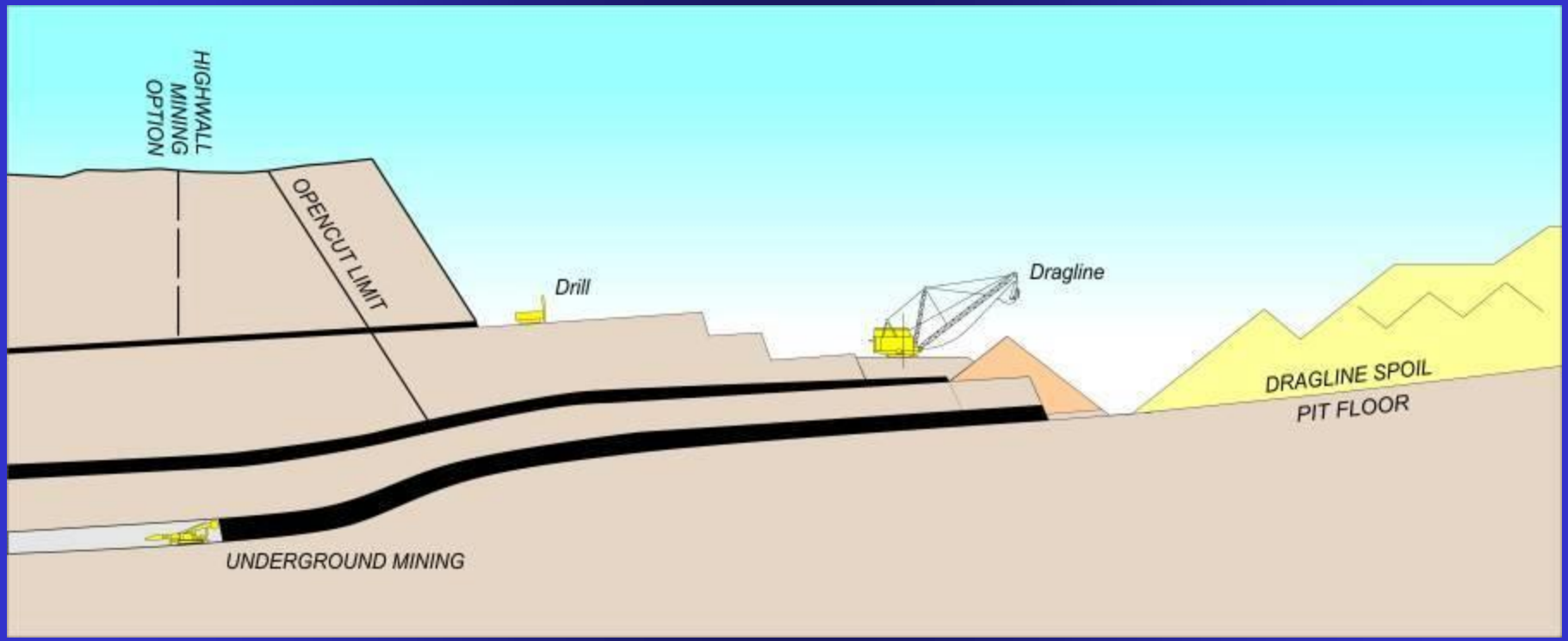


BALANCED SCORECARD APPROACH



EXAMPLE MINE

- Strategic decisions



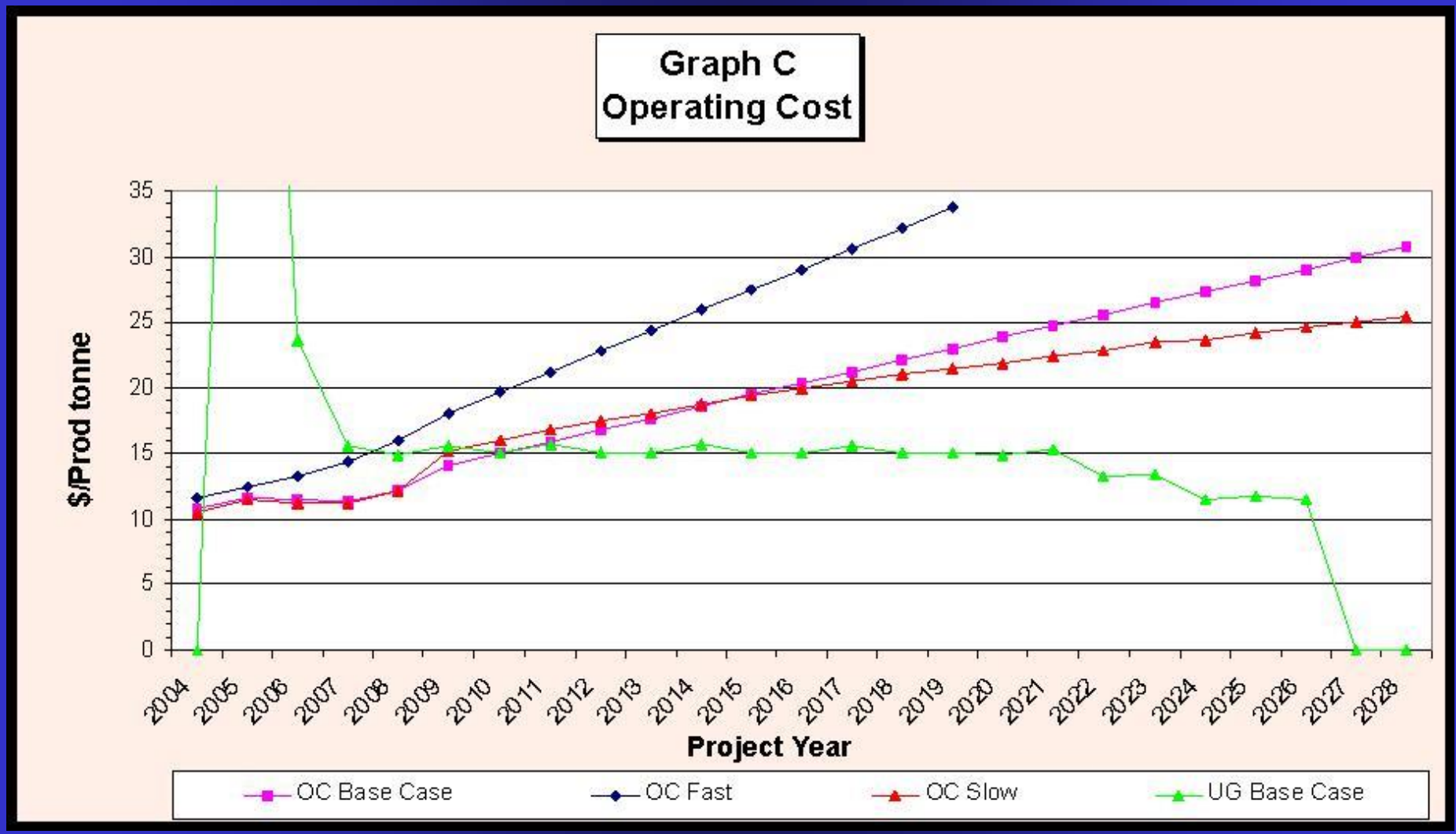
OPEN CUT

- 60 m to 180 m deep
- 150Mt reserves
- Strip ratio from 6.6 bcm/t to 15 bcm/t
- Selling price from $25 to $30 per tonne
- Existing 90 cu.m dragline
- Truck and shovel prestrip

UNDERGROUND

- Longwall operation
- 3 year build up and development
- $300 M Capital
- Producing 7 M tonne per annum
- Ability to develop and operate independently
- Coking Coal Working Section
- Selling price $30 per tonne.

EXAMPLE MINE



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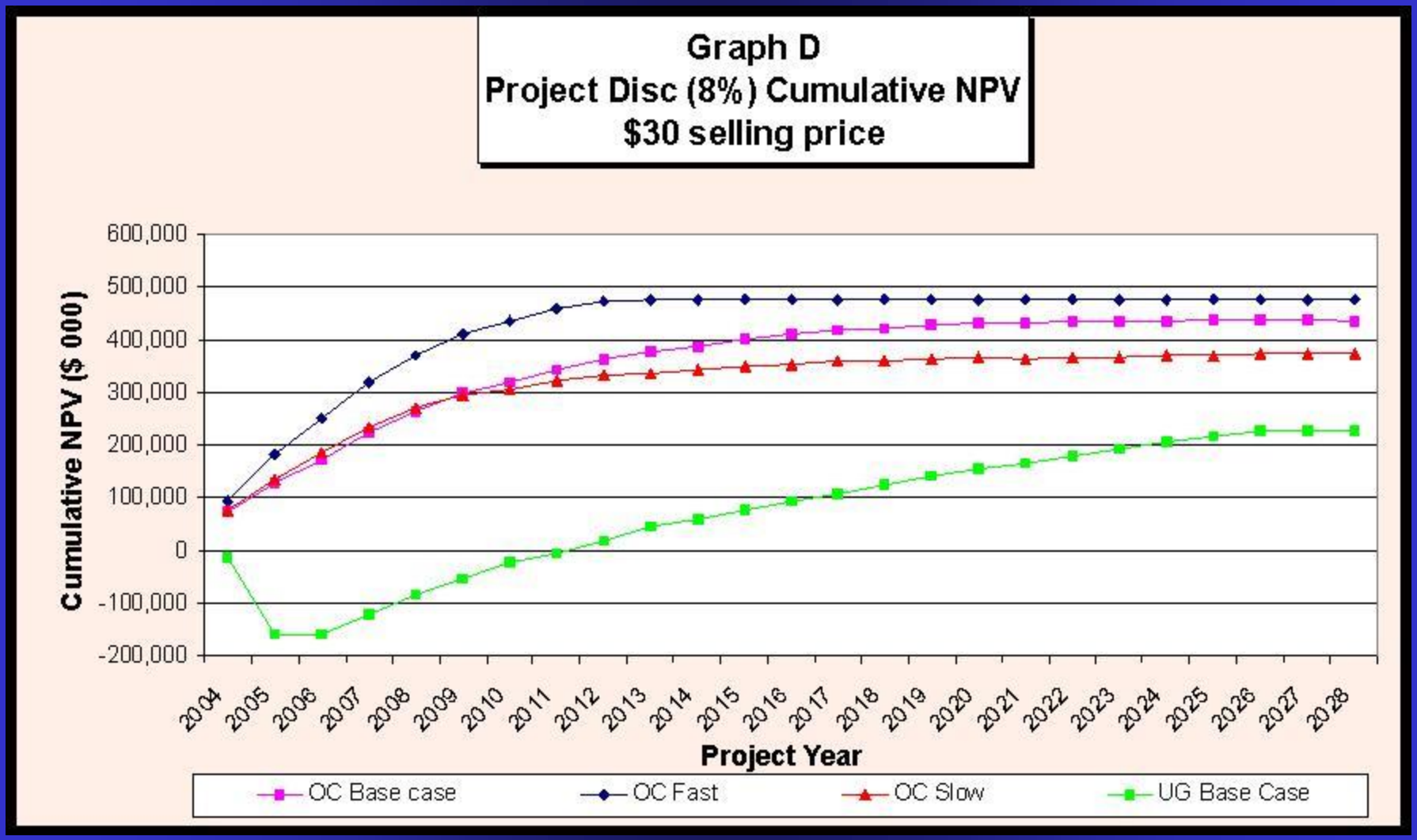

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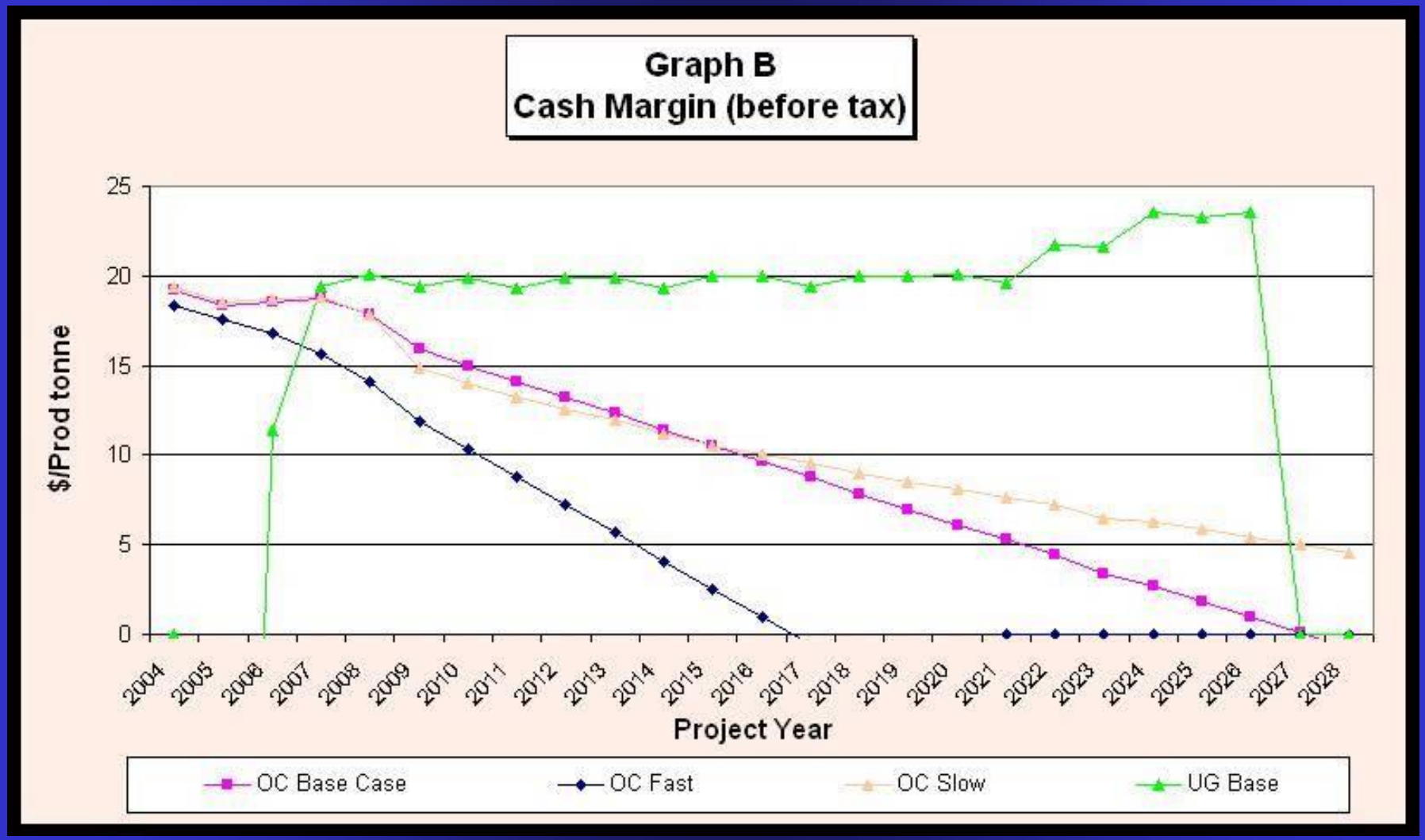
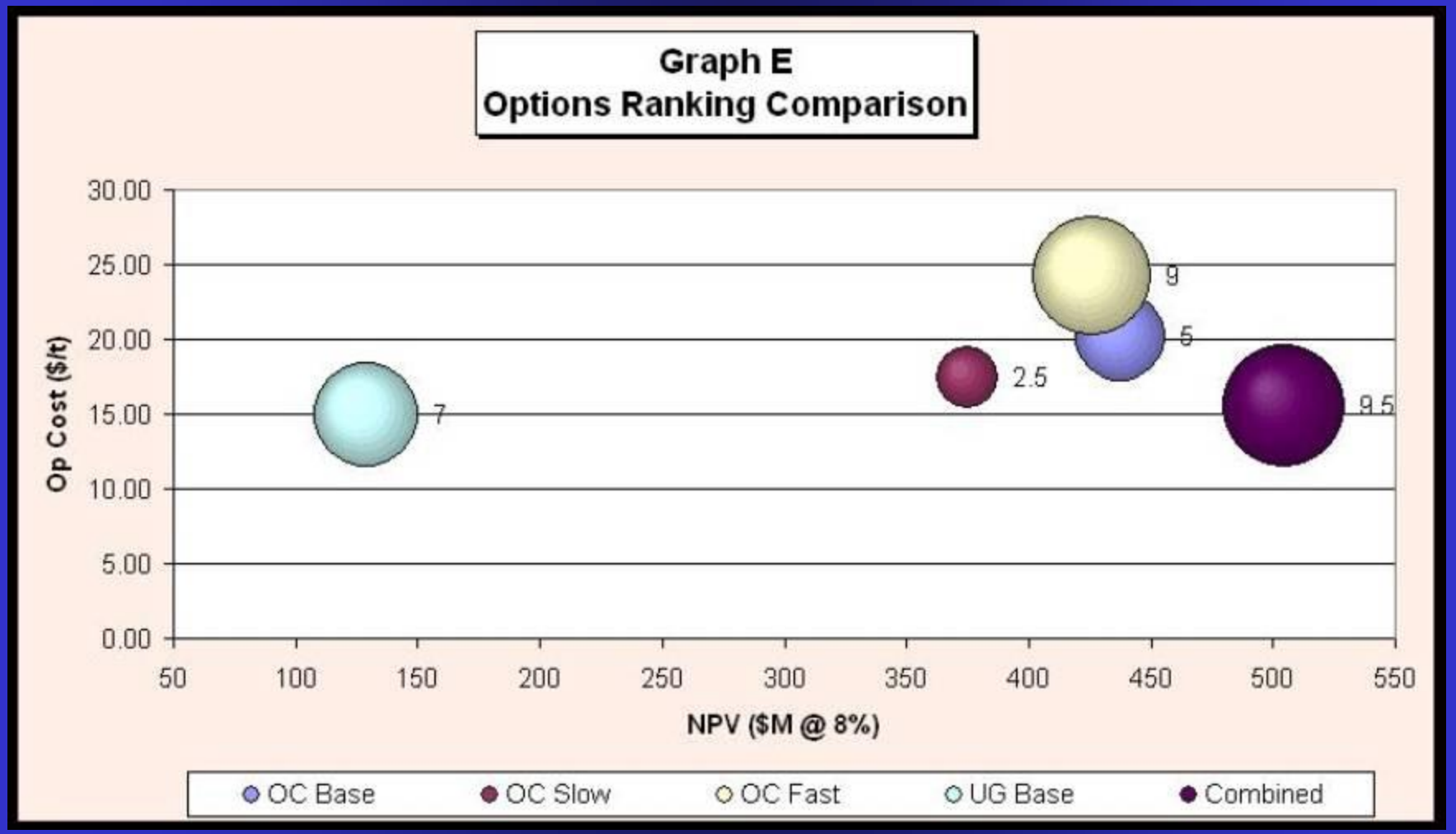


EXAMPLE MINE



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COMMENTS

- Strategic Mine Planning can be cut off too early and have the scope too limited
- But, the scope can also be left too wide for too long ---- "lost in the forest of options"
- There is often conflict with objectives eg low cost and competitive but also low capital and no new technology
- Not including gap analysis or improvements in productivity

CONCLUSION

The choice between Opencut and underground mining is not a simple cost based decision.

It forms part of the Business Strategy.

Business will need to regularly review the plan to accommodate the ongoing change.

Opening the scope early to Strategic planning will aid the business to improve value and competitive advantage.

"Thank you"

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Contact: **Singleton** **(61 2) 6571 2544**

Sydney **(61 2) 9413 3200**

Brian@mineconsult.com.au

ENHANCMENTS

- Gap Analysis
- Balance scorecard
- Risk analysis