INTELLIGENT MINE PLANNING SYSTEMS
A CASE FOR CHANGE
Company Overview - The De Beers Group of Companies

De Beers is a member of the Anglo American plc group. Established in 1888, De Beers is the world’s leading diamond company with unrivalled expertise in the exploration, mining and marketing of diamonds. Together with its joint venture partners, De Beers employs more than 20,000 people across the diamond pipeline, and is the world’s largest diamond producer, by value, with mining operations in Botswana, Canada, Namibia and South Africa. As part of the company’s operating philosophy, the people of De Beers are committed to Living up to Diamonds by making a lasting contribution to the communities in which they live and work, and transforming natural resources into shared national wealth.

Operating Assets
1. Current reality – a case for change
   - Mine planning tools we use and processes we follow
   - Mining methods – Some typical planning constraints
   - How are we impacted by what’s available

2. Art of the possible? – shifting the paradigm
   - Another view, ....... another vision
   - What should good look like, would that be good enough?

3. Key audience takeaway

4. Q & A
The tools we use and processes we follow – Study and Construction Phases

- Ore body Model
- Design and Layouts
- Sequence
- Rules and Rates
- Schedule
- Construction Volumes
- Resources
- Consumables
- Estimates
- Input to Financial Model

**Geoscience modelling software** to create solids, grade, structural and Geotech models.

**Mine design software** for infrastructure layout based on design excavation dimensions and spatial configuration.

Assign deployment sequence and priorities.

Assign basic advance rates and generic rules.

**Simulating software** for man and equipment requirements based on inputs. **Other simulation software** for e.g. static ventilation requirements.

**Spatial progression, quantity and quality - output of Scheduling software**

**Scheduling software**

**Simulation software** for man and equipment requirements based on inputs.

**Application** to calculate consumable requirements per time unit, basis for time related stock levels.

**Estimation software** to do cost estimation based on consumables requirement, material flow and product generation.

**Financial modelling software** to determine revenue and expenditure flow.
The tools we use and processes we follow - Production

**Design and Layouts**

- Mine design software for production excavations based on design excavation shape, dimensions and spatial configuration

**Sequence**

- Assign deployment sequence and priorities

**Rules and Rates**

- Production and ore flow modelling software
- Assign deployment relationships, production rates, shut off grades etc.

**Schedule**

- Scheduling software

**Production Volumes**

- Spatial progression, quantity and quality - output of Scheduling software

**Resources**

**Consumables**

**Estimates**

**Input to Financial Model**

- Simulation software for man and equipment requirements based on inputs.
- Other simulation software for e.g. static ventilation requirements

- Application to calculate consumable requirements per time unit, basis for time related stock levels

- Estimation software to do cost estimation based on consumables requirement, material flow and product generation

- Financial modelling software to determine revenue and cash flow
Which mining methods do we employ

UNDERGROUND MINING
- Underground Mine Access
  - Shaft, Ramp, Adit
- Underground Mining Methods
  - Selective Mining Methods
    - Shrinkage Stopping, Narrow reef Tabular Mining, Room and Pillar, Resuing, Rib Pillar, Drift & Slash, Longwall Mining,
  - Massive/Bulk Mining Methods
    - Sub-Level Open Stopping, Block Caving, Sub-Level Caving, Vertical Crater Retreat, Front Cave, Inclined Cave, Blast Hole Open Stopping
  - Mining employing Backfill

SURFACE MINING
- Open Pit, Quarrying, Strip Mining, Beach & Marine, Alluvial, Shallow Water Dredging

SUBSEA MINING
- Marine Dredging, Drill and Crawler Ships, Vertical Pit Mining
Beach & Marine – Namdeb Land operations
Beach & Marine – Namdeb Land operations

[Graphical data representation]

Legend:
- Dec 2012 Survey
- End 2012
- End 2013
- End 2014
- End 2015
- End 2016
- End 2017
- End 2018
- End 2019
- End 2020
- End 2021
- End 2022
- End 2023
- SC17 tonnages
Effect of beach accretion at No 3 Plant area

Mid 2011
Subsea Mining
Subsea Mining – DBMN Drill and Crawler Ships
Subsea Mining – DBMN Drill and Crawler Ships
Resource Blocks
(Ready-to-mine blocked Resource)

- Resource estimated into 100m x 100m or 50m x 50m blocks
- Vessels mine panels to maximise productivity (minimise spread laying time)
- Typical panels are <400x400m (anchor laying constraints) & > 40,000m² (to minimise spread laying time)
- Mine planning system requires grouping of blocks into panels that will maximise contribution and to sequence these panels for the fleet of 5 vessels with the aim of maximising NPV
- Fleet of vessels have different types of terrain that they can mine. Resource is allocated to vessels
- Vessels allocated to same resource type need to compete whilst maintaining vessel profitability
Vessel Spatial Constraints

Congestion on Northern areas

- Large Bit Vessel buffer (DA, DP, GP)
- Small Bit Vessel buffer (GB)
- Crawler Vessel buffer (Mafuta)

Southern areas nearly depleted

- Example of fleet placement & spatial constraints associated with 2 NM distance between vessels
- Discreet resource nodes required to accommodate entire fleet
- Current marine mine planning systems are unable to account for e.g. spatial constraints
Art of the Possible – What could good look like…. would that be good enough?
Art of the Possible – What could good look like…. would that be good enough?
Art of the Possible – What could good look like…. would that be good enough?

- Example of fleet placement & spatial constraints associated with 2 NM distance between vessels
- Discreet resource nodes required to accommodate entire fleet
- Current marine mine planning systems are unable to account for e.g. spatial constraints
Key audience takeaway

• Mine design and planning is time consuming and requires a very specific and scarce skills set. The process is rather disjointed, making use of mine design and implementation scheduling tools (quite often different platforms) talking to a geological block model (sometimes not). Adding to this production scheduling with very unique and often variable output can become quite an intricate combination which generally leaves little flexibility to trade-off multiple designs and plans due the batch nature of the process.

• It is imperative upon the mining industry to develop an intelligent and integrated design/planning/operating system which has the capability to deliver a smarter plan in a shorter time. Adding to this the capability to do dynamic targeting of activities could assist in shortening the critical path from design to production.

• Maintaining dynamic bills of quantities and estimates as the plan progresses can become a rather powerful tool from a financial planning perspective.

• A tool like this may be able to integrate the capabilities of a number of existing reputable bits of software
Key audience takeaway

Solutions
• A single intelligent mine design and planning system
• Multiple iteration capability with repeatable accuracy
• Dynamic and interactive planning tool which can track and optimise for multiple parameters
• 3D Visualisation and interpretation capability

Benefits
• Reduced overall time required to table an optimised mine design and production plan
• Design and planning flexibility, ease of iterations
• Integration between functional areas in your business
• Seamless flow of accurate information and less duplication of effort
• 3D visuals will assist informed decision making during design and implementation stages
• Ability to improve the business case