



Case Study

AT A GLANCE INDUSTRY:
Mining and Beneficiation

COMMODITY:
Iron Ore

CLIENT:
Iron Ore Mine

LOCATION:
Northern Cape

PROBLEM SUMMARY:
Difficulties experienced to optimally utilise stackers and reclaimers at plant feed stockpiles

SERVICE:
Simulation and Decision Support

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ROM Stockpile Management Optimisation

Increased throughput through better efficiency, improved feed grade blending and activity coordination

Abstract:

The mine required a simulation to test various scenarios regarding the mine's plant feed stockpiles. The simulation model needed to assist the client to determine the optimal stockpile management strategy and operating philosophy in exceptional situations.

Keywords:

Stockpile, Simulation, Increased Throughput, Feed Grade, Blending, Customised Toolkit, Optimisation, Best Practice Application



Problem Statement

The client required a dynamic simulation solution to assist with creating the optimal stockpile management strategy.

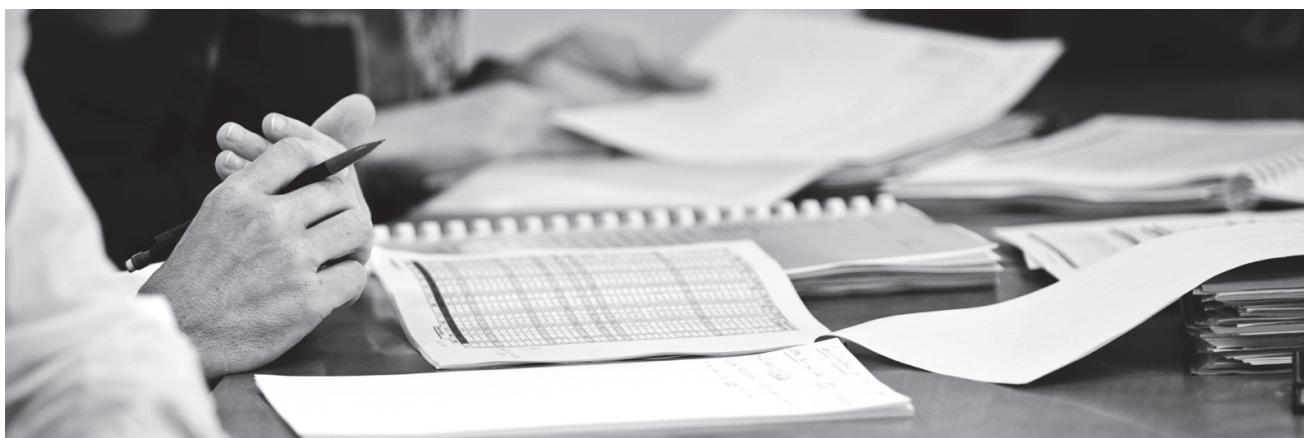
Material is transported by conveyors from the mines to 12 different run-of-mine stockpiles situated before the plant. The run-of-mine stockpiles serve as the handover point from the mines to the plant and are operated with stackers and reclaimers. The material is then sent to on-grade and off-grade plants.



Project Objectives

Mine Production Schedule:

- › Assist with implementing best practices at the ROM stockpiles
- › Increase tonnes throughput
- › Maximise efficiency of the stackers and reclaimers
- › Coordinate stockpiling actions between various control rooms
- › Optimise the plant feed grade by assisting with the blending process of high- and low-grade material





Method

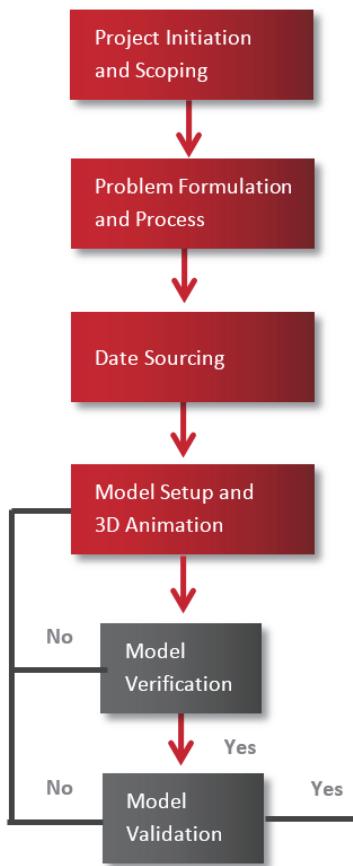
VBKOM followed its standard process for simulation as depicted on the figure to the right.

The problem and process definition was documented before a decision on the simulation technique was made. During this step the following was established:

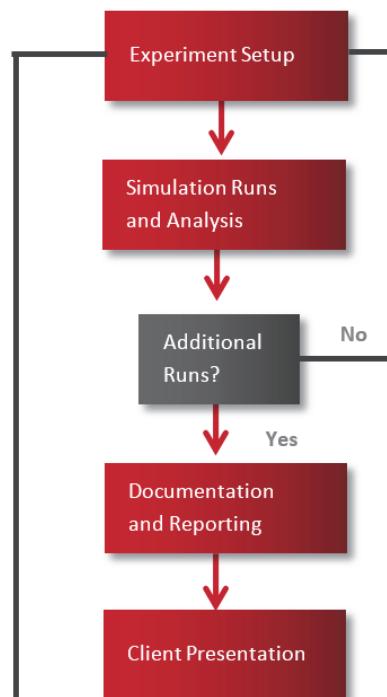
- Required operating principles and conditions
- Material process flow
- Production and equipment rates and ranges
- Mining schedule

Variability estimation of on/off grade accuracy on mining schedule.

Phase 1: Baseline Model



Phase 2: Scenario Analysis



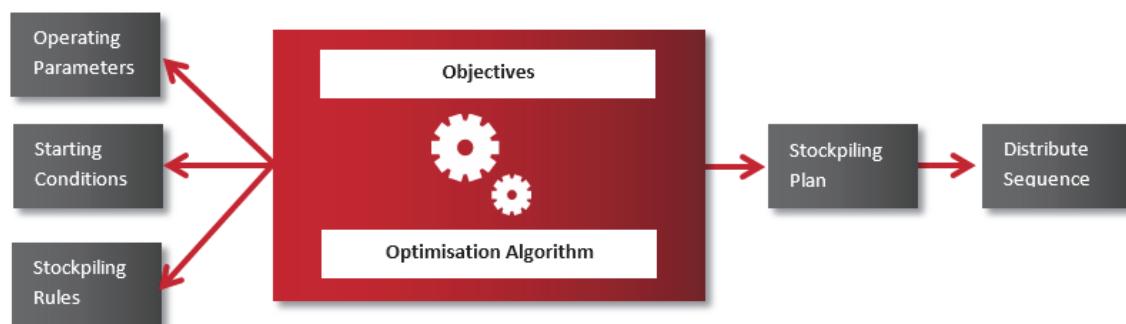
Once the problem was defined the customized Excel add-on simulation tool was selected by considering the following criteria:

Simulation Packages	High Level	Detail	Operational	
Tool	 Monte Carlo	 Object Based Simulation	 Visual Basic Customised Excel Add On with Visual Basic Problem Solver	 Evolver <small>Sophisticated Optimization for Spreadsheets</small> Linear Programming
Simulation Type	Range Distributions	Process	Complex Constraints Problem Solving Algorithms	Complex Formula Problem Solving Algorithms
Usage Differentiator	Scenario Sensitivity Analysis	3D Visual Result View and Dynamic View of Material Flows	Variable Constraints	Fixed Constraints
Result Delivery	Weeks	Months	Weeks to Months	Months
Results	Graphs	3D Videos with graphs	Graphs and basic animation	Calculated Values
Pro's	<ul style="list-style-type: none"> › Quick Delivery › Low Cost › Good problem formulation 	<ul style="list-style-type: none"> › Higher grain of information › Complex constraint evaluation › Visual Movement Outputs, Client Specific Dashboards › Re-usable objects 	<ul style="list-style-type: none"> › Customised for Client Requirement › Very user friendly 	<ul style="list-style-type: none"> › Optimal solutions › Quick solving of repetitive problems
Con's	<ul style="list-style-type: none"> › Graphs only › Use of averages and lower grain of information 	<ul style="list-style-type: none"> › Consultant reliance to run scenarios 	<ul style="list-style-type: none"> › Basic graphics › Not 100% reusable at other site without customisation 	<ul style="list-style-type: none"> › Setup for complex constraints may take a lot of time



Project Results

A customised Excel add-in software application ("Stockpile Optimiser") was created that assists the client with decision-making at the ROM stockpiles. The software analyses thousands of sequences that the stackers and reclaimers should follow and chooses the sequence that will yield optimal results.



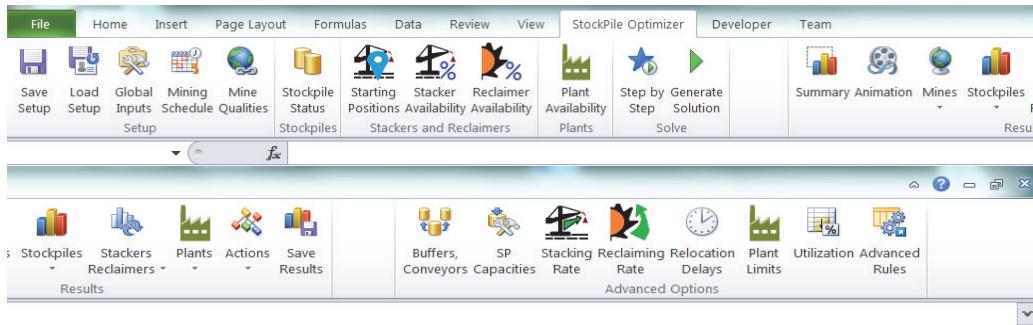
This software was handed over to the client so that they can create stockpiling plans on a daily basis and to do 3-monthly planning.

The software optimisation rules where defined:

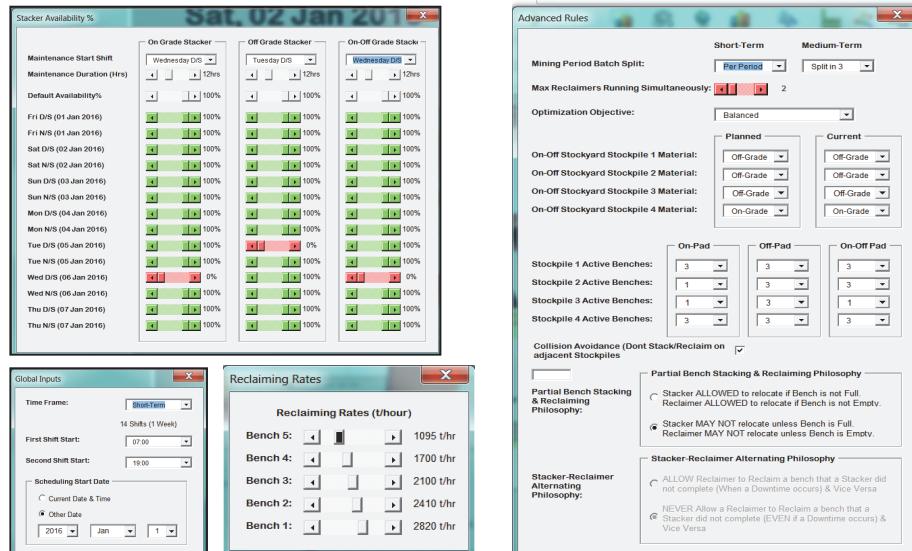
- › Avoiding Stacker and Reclaimers coming in close proximity to one another ("Collisions")
- › Stackers and reclaimers not "Interfering" with the other machines sequence
- › Stacking and Reclaiming Complete benches before relocating
- › Allow for multiple options with regard to material types allowed on each stockpile
- › Different options can be considered for active benches ("Bottom-bench-stacking" etc.)
- › The amount of allowed reclaimers running at any given time can be adjusted (To allow for a more flexible maintenance schedule)

The customised model included:

- › An Excel ribbon with custom buttons:



- › Parameter setup screens:



Stacker Availability %

Maintenance Start Shift	On Grade Stacker	Off Grade Stacker	On-Off Grade Stacker
Fri D/S (01 Jan 2016)	100%	100%	100%
Fri N/S (01 Jan 2016)	100%	100%	100%
Sat D/S (02 Jan 2016)	100%	100%	100%
Sat N/S (02 Jan 2016)	100%	100%	100%
Sun D/S (03 Jan 2016)	100%	100%	100%
Sun N/S (03 Jan 2016)	100%	100%	100%
Mon D/S (04 Jan 2016)	100%	100%	100%
Mon N/S (04 Jan 2016)	100%	100%	100%
Tue D/S (05 Jan 2016)	100%	100%	100%
Tue N/S (05 Jan 2016)	100%	100%	100%
Wed D/S (06 Jan 2016)	0%	0%	0%
Wed N/S (06 Jan 2016)	0%	0%	0%
Thu D/S (07 Jan 2016)	100%	100%	100%
Thu N/S (07 Jan 2016)	100%	100%	100%

Global Inputs

Time Frame: Short Term
First Shift Start: 07:00
Second Shift Start: 19:00
Scheduling Start Date: Current Date & Time
Other Date: 2016 Jan 1

Reclaiming Rates

Reclaiming Rates (t/hour)

Bench	Rate (t/hr)
Bench 5:	1095 t/hr
Bench 4:	1700 t hr
Bench 3:	2100 t/hr
Bench 2:	2410 t hr
Bench 1:	2820 t hr

Advanced Rules

Short-Term Medium-Term

Mining Period Batch Split: Per Period Split in 3

Max Reclaimers Running Simultaneously: 2

Optimization Objective: Balanced

On-Off Stockyard Stockpile 1 Material: Off-Grade
On-Off Stockyard Stockpile 2 Material: Off-Grade
On-Off Stockyard Stockpile 3 Material: Off-Grade
On-Off Stockyard Stockpile 4 Material: On-Grade

Stockpile 1 Active Benches: 3
Stockpile 2 Active Benches: 1
Stockpile 3 Active Benches: 3
Stockpile 4 Active Benches: 3

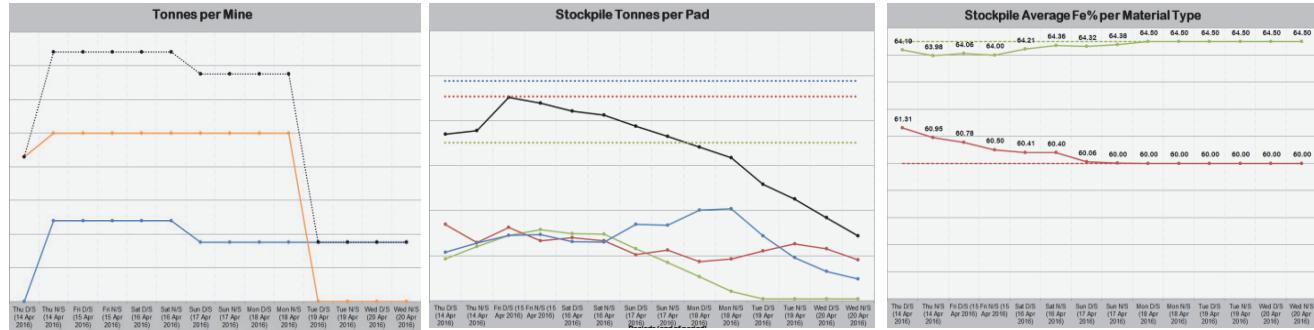
On-Pad Off-Pad On-Pad

Collision Avoidance (Dont Stack/Reclaim on adjacent Stockpiles)

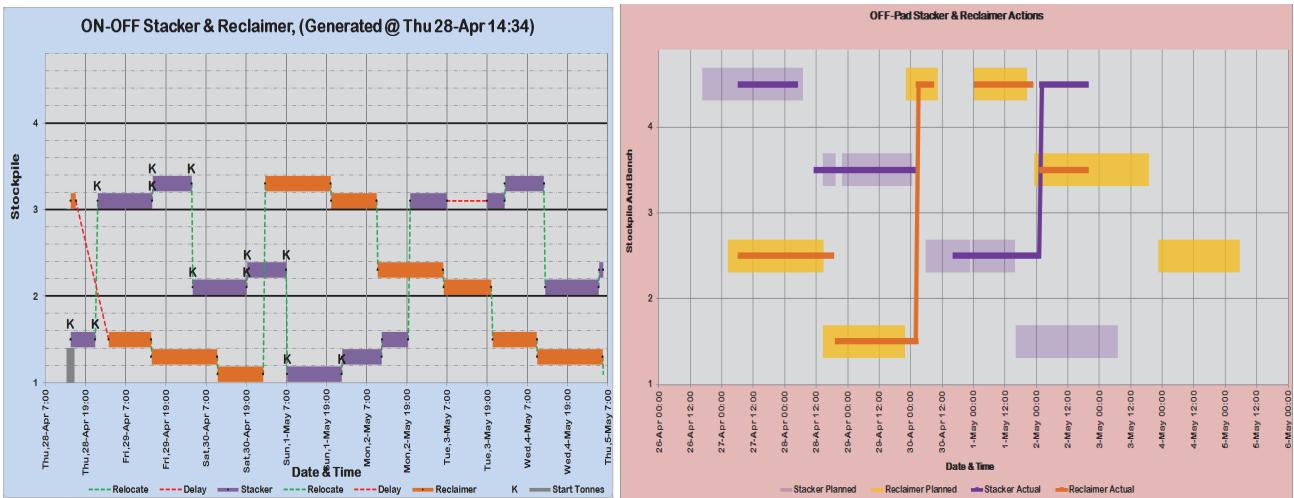
Partial Bench Stacking & Reclaiming Philosophy:
 Stacker ALLOWED to relocate if Bench is not Full
 Reclaimer ALLOWED to relocate if Bench is not Empty.
 Stacker MAY NOT relocate unless Bench is Full
 Reclaimer MAY NOT relocate unless Bench is Empty.

Stacker-Reclaimer Alternating Philosophy:
 ALLOW Reclaimer to Reclaim a bench that a Stacker did not complete (When a Downtime occurs) & Vice Versa
 NEVER allow a Reclaimer to Reclaim a bench that a Stacker did not complete (EVEN if a Downtime occurs) & Vice Versa

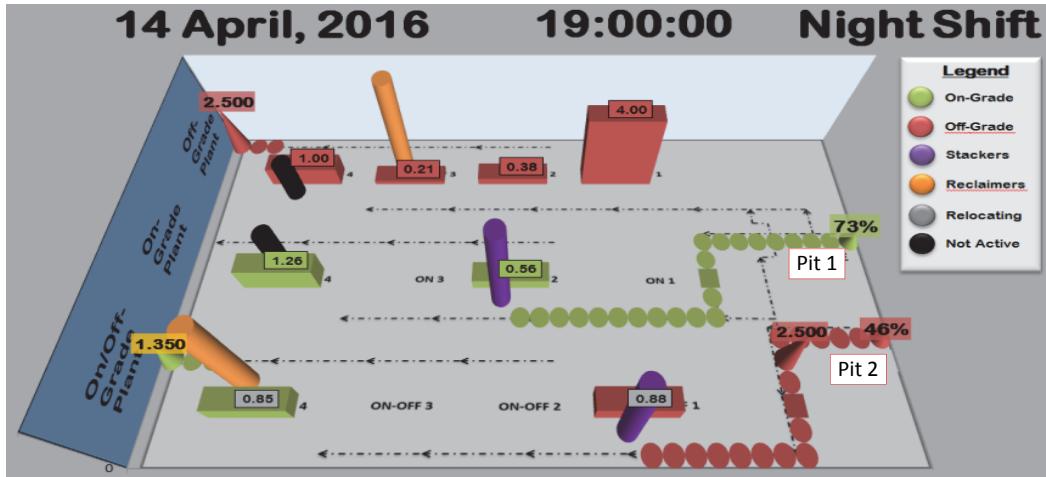
► Graph outputs:



► Sequence and Compliance Management:



► Graphical Animation





Customer Value

Through the use of VBKOM's Stockpile Optimiser:

- › The operating hours of the stackers and reclaimers can be reduced by 8.2%
- › The tonnes throughput can be increased by 7.5% if the mines are able to supply the additional material

