

# A Blending Case Study

*Blending ores from multiple stockpiles is a common mining operation. Most mines rely on spreadsheet-based calculations to program blends for processing feeds. These stockpile drawdown schedules often owe more to intuition than science, making for unreliable forecasts and lost profit opportunities.*

*MineCo's Manganese mining and processing operation included multiple pits, grades, products, and other factors that made production forecasting particularly difficult.*

*XempleX created an automated blending solution for MineCo to calculate optimum blends and production forecasts for the entire life of mine (LOM). Reports were presented in a familiar format, but all data consolidation and calculations were managed in the flexible and controlled XempleX environment.*

*The solution was extremely cost-effective, paying for itself almost immediately through increases in production efficiency.*

## Introduction

*A complex mining and recovery operation.*

MineCo has a large Australian Manganese (Mn) mining and recovery operation. Their site has a large number of working pits producing seven types of ore, all transported to a common stockpiling area.

*Optimise crusher feeds and product blends.*

Each ore type is classified by Mn grade, contaminant content (P, Pb, Fe, Al<sub>2</sub>O<sub>3</sub> and SiO<sub>2</sub>), and other physical properties, and is tagged by colour. Each colour has different crushing requirements, which affects equipment capacity calculations. Each colour also has different recovery characteristics.

*Reliable production forecasts for the entire LOM.*

Processed product is stockpiled as High Grade (HG) or Low Grade (LG) lump or fines. Customer orders for lump or fines of a specific grade profile are fulfilled by blending from the HG and LG stockpiles as required.

MineCo needed a system to calculate blending profiles to produce the four base ore products with specific quality characteristics. Initial attempts using spreadsheets depended heavily on operator knowledge and their ability to estimate blending solutions. It could take several days to run a single scenario for even a few years of mine operation. Complete life of mine (LOM) simulations were impractical.

XempleX provided a solution to manage the blending requirements of MineCo's multiple pits, 7 colours and 4 products. It was easy to use, ran in a fraction of the time of the old solution, featured familiar report types, minimised data entry, automated schedule import and consolidation, and was easily extendable.

The availability of high quality information for the entire LOM made it possible to make better planning decisions and increase revenue.

This paper describes how the XempleX solution consolidated mine schedule information and devised a processing schedule to extract the maximum amount of specified product over the entire LOM.

The company name "MineCo" is an alias. Data and reports have been altered to protect commercial confidentiality.

## ROM feeds

*Automated data consolidation direct from mine schedules.*

The first and most simple data management task was to combine over a dozen pit mining schedules into seven feeds, for each of the ore type colours. This was achieved with an automated Xemplex data import and consolidation process. Displayed as a chart, this information graphically illustrated how the schedules would combine over the entire LOM.

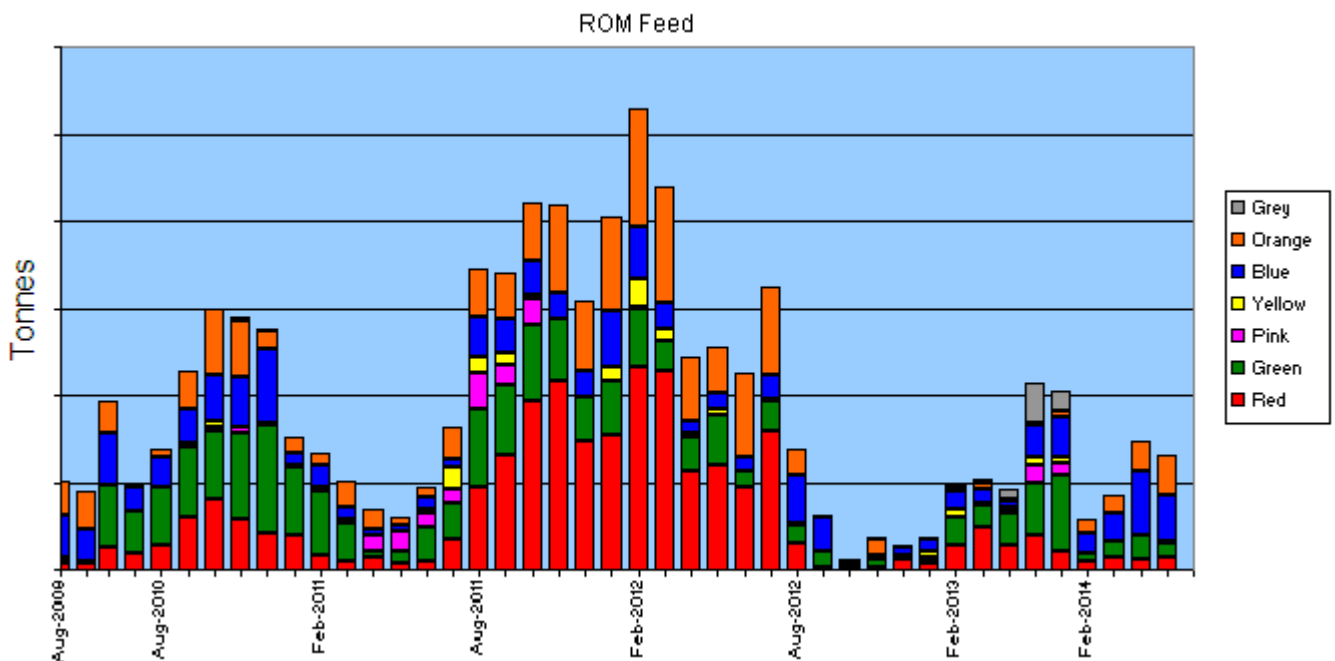


Figure 1: Scheduled life of mine production of 7 ore types out of multiple pits.

It is clear that the schedules in this scenario would lead to uneven rates of ore *extraction*. Whether this would have an impact on *production* would be revealed by the Xemplex production forecasts.

## ROM stockpiles

Ore stockpiles grow with mine operations and shrink with the demands of processing. A simple schedule consolidation can show the growth of stockpiles, but is not able to model drawdown.

The Xemplex blending solution modelled both the growth and drawdown of these stockpiles for the entire LOM.

*Understand stockpile changes.*

In this example, "Red" is high grade ore always in demand for crushing and blending. Around August 2011, the supply of Red ore is forecast to outstrip the other feed colours, such that the amount mined could not be used in the required product blends. The Red stockpile will grow rapidly.

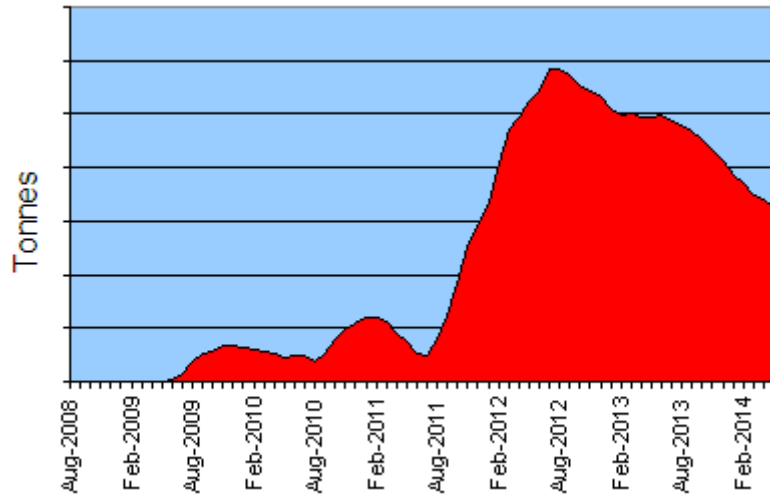


Figure 2: Red ROM stockpile closing balance for each month in LOM.

The next chart shows the behaviour of the "Blue" ore stockpile. This report illustrates that there is rarely a surplus of Blue ore. An empty stockpile may indicate an undersupply that limits blending options, and results in the surplus Red as shown above.

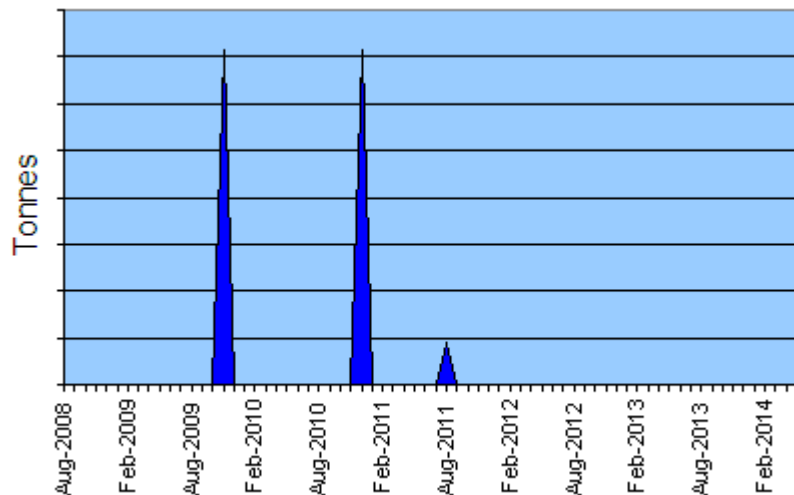


Figure 3: Blue stockpile closing balance for each month in LOM.

Find weaknesses in supply.

If the process feed forecast predicts that there will be insufficient ore to process at full capacity, these ROM stockpile reports can be used to identify which colour's lines of supply are the problem. It may then be possible to adjust the mining schedules to compensate.

## Process feeds

Don't waste profits by overshooting grade targets.

The goal of the recovery and blending processes is to generate the maximum quantity of product that is as close to minimum tolerances as possible. Supplying higher grade material than the customer is paying for is simply a waste of profits.

The first step is to specify product tolerances. These figures needed only to be entered once for each scenario, using a simple form as illustrated below. This single point of entry significantly reduced the risk of error.

Specifications	Ore Type			
	HGL	LGL	HGF	LGF
Mn (min.)	47%	36%	43%	36%
Fe (max.)	7%	15%	8%	16%
SiO <sub>2</sub> (max.)	14%	12%	14%	11%
Al <sub>2</sub> O <sub>3</sub> (max.)	1%	1%	1%	1.8%
P (max.)	0.07%	0.08%	0.07%	0.08%

Figure 4: Sample product specifications for Manganese ore.

A multi-variate blending algorithm.

The Xemplex multi-variate blending algorithm was used to determine the best available processing and recovery program to meet these goals. It incorporated ROM feeds directly from the mine schedule, and included practical operational limits such as crusher capacity. Both crusher capacity and recovery calculations varied with the type of ore feed.

A process feed chart displayed month-by-month blends for the entire LOM.

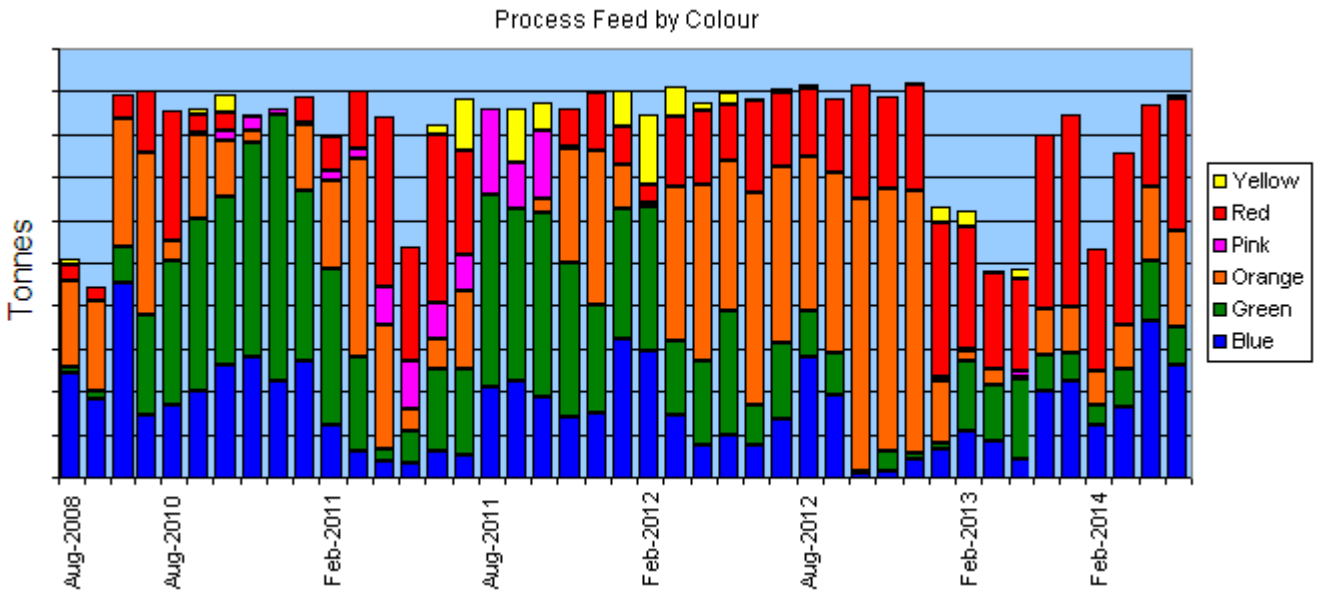


Figure 5: Optimum process feed blends calculated to meet product quality characteristics.

Plan for maximum production capacity.

Ideally, every month of production should run at maximum processing capacity. This report allowed MineCo to identify the times where the mine schedules would create shortages in processing feeds (see 2008, 2011 and 2013). This information could be used to modify the schedule of one or more pits to ensure that the crusher works continuously to capacity, and with the best blend.

The figures for individual months could also be examined in detail. The following chart shows the crusher throughput for July 2010.

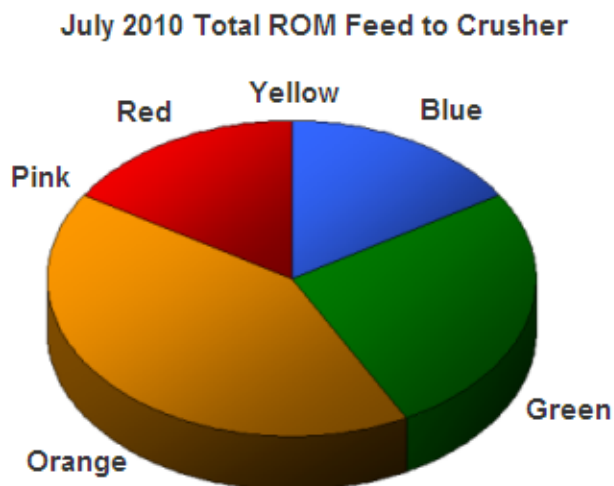


Figure 6: Sample report of Crusher (process) feed blend forecast for the month of July 2010, in Tonnes.

## Product feeds

Forecast product quantity and composition.

The XempleX blending solution was able to forecast the exact quantities and composition of saleable product produced for each month in the LOM. Composition profiles included both Mn content and contaminant levels for Al<sub>2</sub>O<sub>3</sub>, Fe, P, Pb and SiO<sub>2</sub>.

In the following report, each horizontal bar shows the level of one component within its own tolerance range. Mn should ideally be as close to the minimum grade as possible, while contaminants may fall anywhere within their individual tolerances.

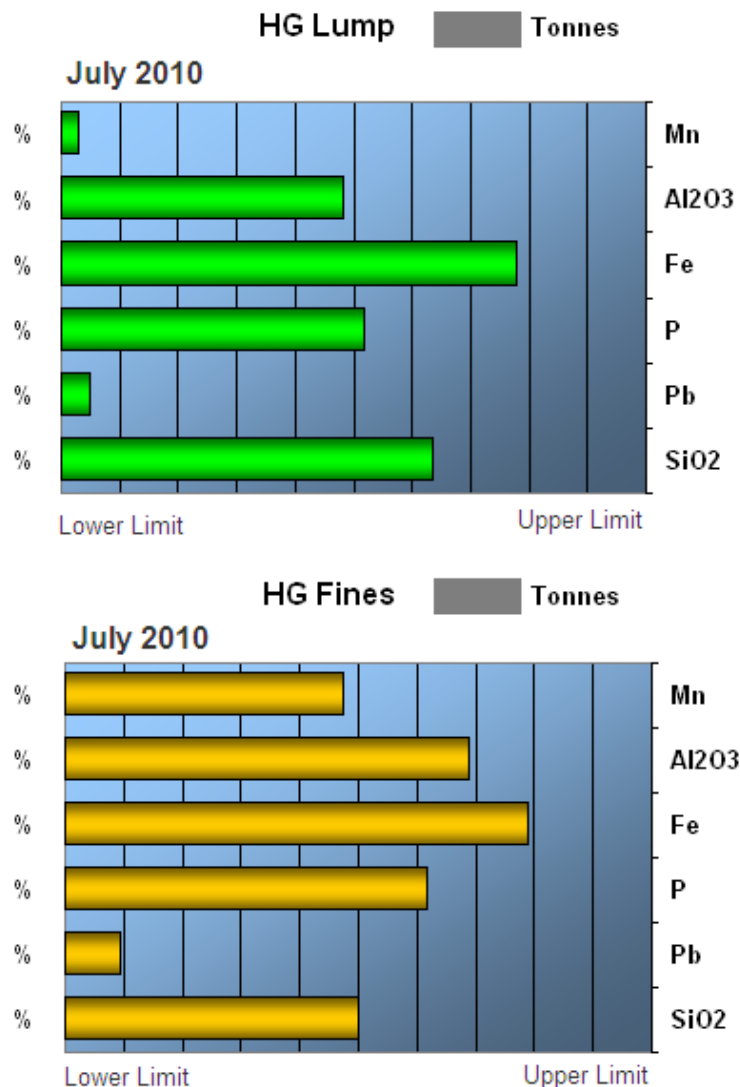


Figure 7: Sample report of monthly product feed of Mn High Grade Lump and High Grade Fines for July 2010.

## Product stockpiles

LOM product forecasts.

The final set of reports shows the forecast amounts of each product for the entire LOM.

This sample chart shows the cumulative High Grade Lump Mn production output under the proposed mine schedule.

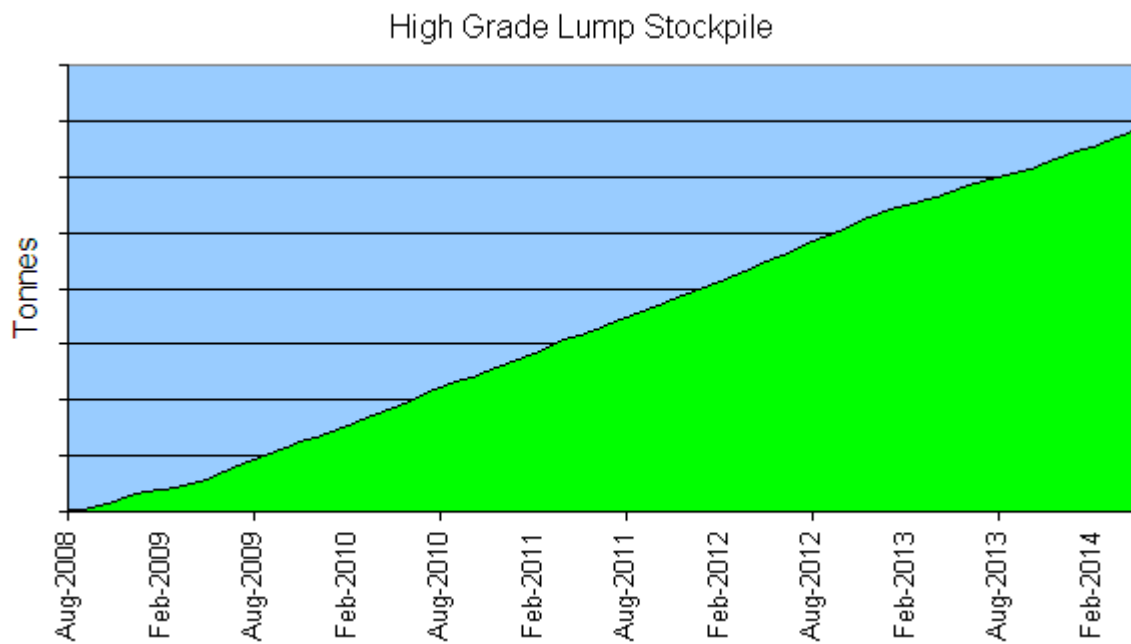


Figure 8: High Grade Lump product stockpile over LOM.

It would take only minutes to recalculate these figures for a new scenario based on different quality parameters, or for a different mine schedule.

## The future

Extend, expand, improve. Easily.

This blending solution will be able to adapt easily and quickly to changes to the mine, schedule, product parameters, or equipment parameters. Additional reports and functionality can also be added as required and without disruption to operational systems.

It can be extended through the production and supply chain to provide additional blend process support in both planning and operations. Potential applications include mine post processing, processing to port, and port to ship.



*Link blending, forecasting and revenue calculations directly.*

XempleX solutions can be deployed rapidly and are extremely flexible. They can support different schedule formats, product quality parameters, ore types or recovery calculations. Time scales and reporting periods can be as long- or short-term as required.

## Conclusion

*Maximise mining profits.*

Blending is an important mining operation, and getting it right can help to maximise the potential of a mineral resource. In even relatively simple operations, performing blending calculations with generic desktop tools can be time consuming and inaccurate, both increasing costs and reducing profits.

XempleX provided a life of mine blending solution that managed the complexities of consolidated ROM feeds, and crusher and recovery characteristics for multiple types of ore. For MineCo this significantly increased their opportunities for profit.

*XempleX business solutions are cost-effective, efficient and flexible.*

XempleX can provide dependable solutions for integrating and consolidating financial, accounting, geotechnical, and processing data associated with mining and resources industries. In partnership with industry specialists, a XempleX solution can be created for any type of organisation.

Contact your local XempleX consultant to discover how your organisation can benefit from this new perspective in business solution design.

## Contact

To find out more about XempleX solutions, or if you are interested in becoming a XempleX consultant, contact:

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Published: Tuesday, 30 September 2008

Version: 1

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