Mine reconciliation – for better or worse!

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Abstract

Why do we look for better reconciliation when times get tough? Why wait? Mine reconciliation should be a priority throughout the good times too. In fact, with good reconciliation, those good times are going to be even better and will help pave the way to success through those preventable bad times. Reconciliation throughout the entire mining value chain requires the capture, validation, and analysis of copious amounts of data. This task can be daunting for a team in a small mine, let alone reconciling across a suite of large mines.

This paper will outline the different ways we can reconcile across the value chain, why we should reconcile over differing periods of time and how Snowden's solution to proving reconciliation can be a simpler, reliable and transparent process. Snowden's Reconcilor is proving to be a valuable tool on any mining scale, by capturing, validating, sorting and reporting data for timely decision making by the site geologist through to corporate management.

By instigating vigorous reconciliation, you are setting your mine up for the future. Not only will you have the means to analyse your current processes and measures, but you will have the opportunity to identify and improve your mine's performance from the resource model through to the final product.

Biography

Pamela De Mark is a Senior Consultant at Snowden Mining in Vancouver, Canada. She has more than 16 years experience in the mining industry, particularly in underground gold mines. Pamela worked as a production and resource geologist for ten years at mines within Australia and Tanzania, gaining a range of experience including diamond drill hole planning, management, logging, interpretation, and resource evaluation; mapping; sampling; dilution control, QAQC management, and reconciliation. Since joining Snowden in 2006, Pamela has performed resource estimations, technical due diligence studies, technical resource audits, and prepared NI43-101 compliant technical reports for clients in the Americas. Pamela is the Reconcilor domain expert for the North Americas.

Introduction

Reconciliation is essentially the process of identifying, analysing and managing variance between planned and actual results in such a way that it highlights opportunities. These opportunities commonly include: methods to create better estimates; improved designs; tighter and more accurate plans and schedules; improved mining techniques to minimise ore loss and dilution; and identifying ways to increase metal recoveries during the extraction processes. The ability to measure and analyse data in this way enables an operation to design and implement process improvements across the entire mining value chain.

Historically, mine reconciliation is a task undertaken when operations face performance pressures, typically where actual production fails to meet expectations. It tends to be during these times that the process of reconciliation falls to a select few with the necessary experience to analyse data sourced from the multi-disciplined teams involved in mine production. There is growing emphasis in today's mining operations however, to have semi-automated systems developed using agreed business logic to provide data for analysis by teams responsible for optimising an operation's performance. In this environment, reconciliation, and the subsequent decision making process, can be seen to pay dividends in good times and bad.

Mine reconciliation

Across the mine value chain, it is recognised that a range of activities are common to most deposits. These activities include resource estimation, mine design, planning, grade control, mining, material transfer, and ultimately mineral processing resulting in production of the desired commodity. Along this value chain there are also relationships, and comparisons are routinely undertaken to measure and assess mine performance. Another way to look at the mining value chain is as an inverted pyramid (Figure 1) where information grows as you progress up the pyramid. Each process relies on the information from the layer below with reconciliation acting as the reality check between these layers – enabling you to see how good the data and information is. There are three main types of reconciliation: spatial, temporal and physical.
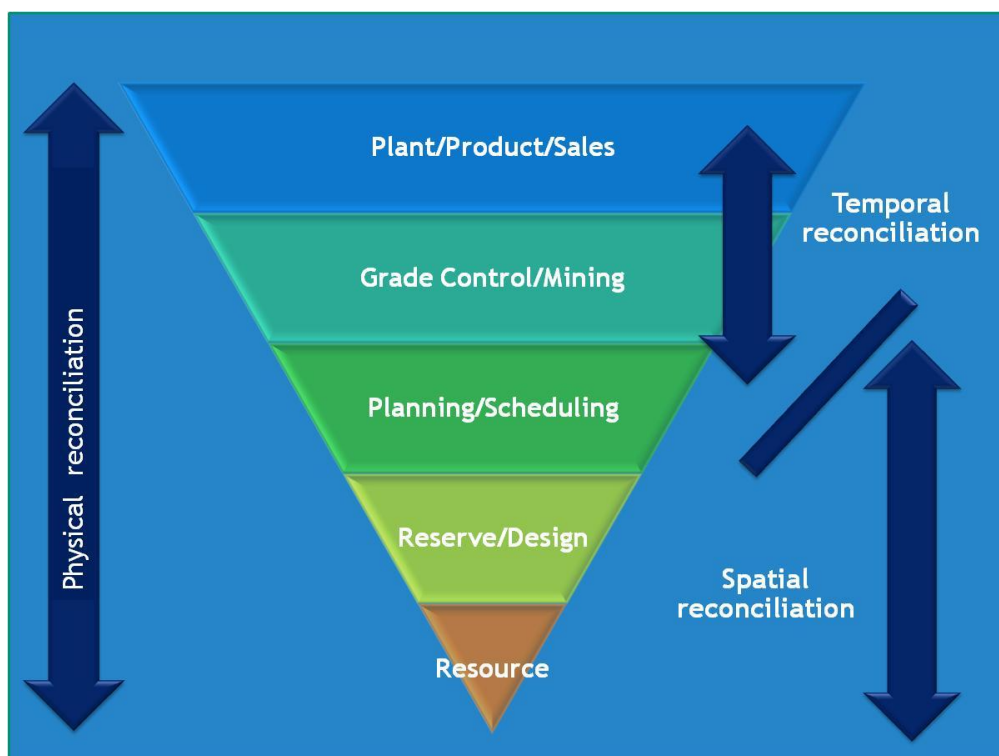

Figure 1 The reconciliation pyramid – temporal, spatial and physical reconciliation managed in Reconcilor

An important aspect of any reconciliation process is to ensure that "apples are compared with apples" – that is, when comparing an estimate against a measurement it must be ensured that the material for which the estimate has been made is the same as the material being measured.

Spatial reconciliation

Spatial reconciliation is the three dimensional or "X, Y and Z" form of reconciliation and can be derived from comparison of predictive models or actual measurements based on a geographic

location. Mining activities have significant impact on reconciliation results if spatial considerations are not taken into account (i.e. over digging ore blocks, survey of the actual mining areas after mining). Spatial reconciliation measures the absolute performance between predictive models and the actual results determined by mapping and survey measurement. It is important in situations such as where material type boundaries are adjusted on the basis of visual ore control or where measurements such as hanging wall pickups are taken during mining. This spatially orientated information forms actual data that can be compared with original geological interpretations and models.

Temporal reconciliation

Temporal (or "time based") reconciliation is the most common form of reconciliation. Temporal reconciliation compares performance across the mining sequence on time based ranges (such as shifts, days, weeks, months, years etc). It does not necessarily compare information from a spatial perspective, which may vary over the short term, but relies on the fact that these geographical discrepancies "smooth out" over longer periods of time, normally months or years. Temporal reconciliation allows tracking of data over time, typically monthly or yearly. Temporal reconciliation can also be applied on a spatial basis, for example such as measuring the performance of an individual underground stope or open pit bench over time.

Physical reconciliation

Physical reconciliation is focused on attributes such as contained metal, various quality parameters and volumes. Typically, physical reconciliation is combined with temporal data and is generally reported over long time periods, quarterly or annually. However, it is also often useful to compare physical characteristics of a model such as total metal, planned dilution, and quality results between different versions of resource and reserve models (after Fouet et al., 2009).

Managing variance

In Snowden's experience, issues associated with mining reconciliation affect all mining operations. Snowden considers that regardless of whether the reconciliation is negative or positive, it is the management of the variance that enables management to make prudent, timely and informed decisions.

Critical to the success of any reconciliation system is the capture of key data. Typically, data may be sourced from (after Morley, 2003):

- resource and reserve models;
- survey of topography to determine the actual mining activities;
- mining personnel's observations of mining activities;
- plant feed sources, such as weightometers and auto samplers;
- plant performance indicators, such as crusher power consumption, cyclone throughput; etc
- plant balance calculations; and
- plant actuals, such as commodity produced, reject and tailings volumes and assays.

There will always be a margin of error in any measurement and these should be estimated and considered in the results. Capturing information automatically and electronically from the source alleviates one aspect of error; the human component. Other sources of error may include (after Glacken and Morley, 2003):

- sampling precision or accuracy issues;
- survey errors, particularly with respect to stockpiles;
- stockpile grade modeling;
- ore held up in underground draw points and ore passes;

- any estimate of stocks associated with sublevel or block caving;
- volume calculation errors within overhanging or partially blocked stopes; and
- estimating in-pit ore stocks.

Dilution of ore, under/over loading of trucks, incorrect tracking of material movements and uncalibrated weightometers are just a few of the other contributing factors which inadvertently affect reconciliation. Collected data influenced by these factors are often incorrectly used as actual measurements, whereas they should be used as indicators of poor mining practice only. Reconciliation highlights the efficiency (or otherwise) of the mining process, and so it is important to separate the 'signal' (the true reconciliation result) from the 'noise' generated by the sources of measurement error (Glacken and Morley, 2003).

Most reconciliation reports focus on long time periods (monthly, quarterly or annually) due to the difficulty in handling residence times of material in stockpiles and processing plants and the time-consuming nature of gathering the necessary data for analysis and reporting. Data that is generated regularly over long periods of time will naturally result in larger data sets that smooth out any short term anomalies and so, more accurately reflect trends (after Riske, 2007).

Reconcilor as a solution

In recognition of the relationships across the mine value chain, Snowden has specialised in reconciliation consulting and developed the Reconcilor software system. The system is customised to each operation to specifically track data from various input systems and report on these relationships right across the operation. The primary objective is to capture mine predictions, actual performance and enable comparisons of data in such a way as to identify potential operation improvements (after Fouet et al., 2009)

Snowden's Reconcilor system provides clients with an innovative, customised solution to assist with their reconciliation needs. The system, which has been developed and refined over 10 years, is based on presenting validated and accurate data in such a way that management can make informed and strategic decisions to optimise their mining operation and increase profitability.

Reconcilor provides:

- automated data capture from commercial mining software packages;
- data stored in a single central data store;
- results via an intuitive interface providing information for data analysis; and a
- flexible and customizable reporting platform.

Snowden recognizes that there is a key set of data management principles that apply to all operations, regardless of differences in location, geology, commodity and culture. The core functionality of Reconcilor was designed on the basis of these key principles, ensuring that the system handles the fundamental issues.

These principles are:

- Make information available to many individuals at different levels of the operation (Figure 2).
- Track data changes and maintain proper levels of security.
- Validate data using company business rules and have errors corrected in the original data source.
- Capture data electronically and automatically.
- Provide a flexible approach to adapt to changing requirements.
- Use robust technology.

Figure 2 Examples of differing home pages of Reconcilor, which offer a high level overview of production statistics, similar to a Key Performance Indicator (KPI) dashboard, particularly favored by management. The home page is fully customized to suit the requirements of the mine site.

Snowden has direct experience with all major geological database and mining software packages. This enables provision of specialised value adding interfaces that let site personnel get a lot more value out of the geological databases.

Reconcilor is used on a daily basis by production staff typically comprising mine geologists, production engineers and surveyors. Each day these personnel check, review and rectify haulage errors and data exceptions detected by the system. In this way, Reconcilor is providing a system to enable validation of the data on a shift by shift basis in an easy to view format. If action is taken to correct errors at the time of detection, reliable ad-hoc reports can be produced at any time. Reconcilor will automatically generate daily and weekly production reports, without requiring any additional work from production staff.

At the end of each reconciliation and reporting period; weekly, bi-monthly or monthly, production personnel use Reconcilor to review comparisons between resource, reserve, grade control, survey and haulage data. Any abnormalities may be viewed and dealt with prior to approving the data. Reconcilor automatically maintains a number of reconciliation graphs on the approved data. Finally, monthly reports are produced and made available to all staff.

Reconcilor facilitates an increase in production as it enables optimization of the quality of the material sent to the plant. Through constant and ongoing calibration of what is actually mined, delivered to the plant, and what Grade Controllers are reporting, the grade control process improves. This results in more accurate definition of waste and ore and higher quality material being delivered to the plant. The constant monitoring of haulage information also allows optimization of what material is moved where and helps minimize unnecessary dilution and ore loss.

When mine site personnel can track and understand, on a daily basis, the relationship between grade predictions made in scheduling and grade control, then adjustments can be made to operations so as to optimize the desired output. In addition, since Reconcilor identifies the relationship information immediately, (Figure 3), changes can be made quickly, as opposed to waiting for results to be calculated at the end of each month. Reconcilor gives production personnel the opportunity to optimize the grades being mined because of the extremely short turnaround time of relevant information.
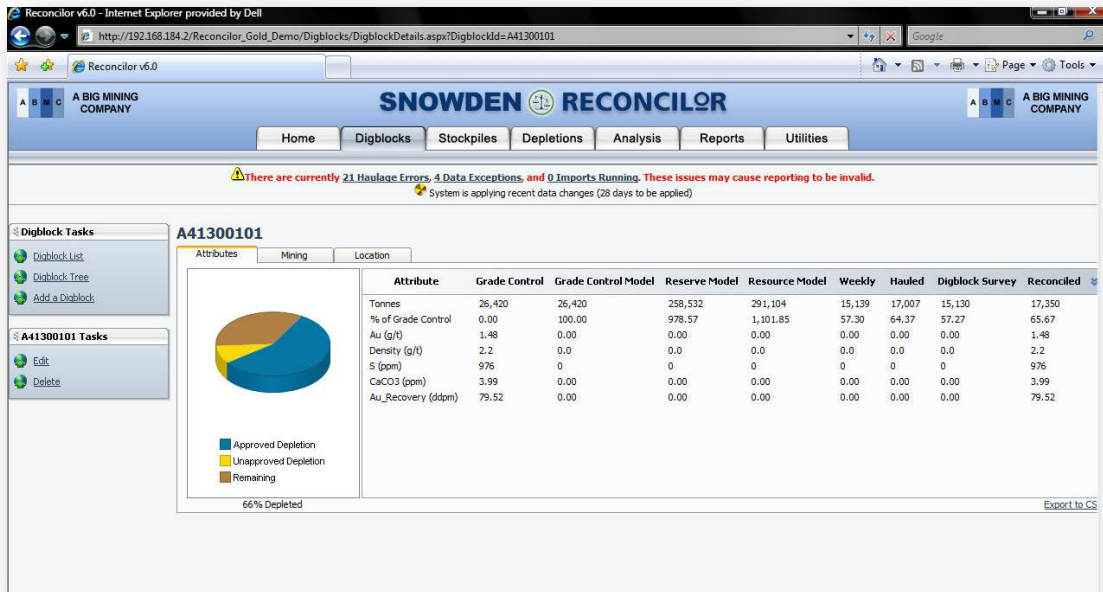
Figure 3 Example of the digblocks/stope/development page of Reconcilor, which offers details relating to tonnage and other attributes associated with an individual digblock/stope/development.

Improved productivity of your people

The production management and reconciliation function at a mine site can be one of the most time consuming functions performed by your employees. Reconcilor has been demonstrated to significantly reduce the time required for this function, allowing personnel to be productive in other areas. Time will be saved in a number of data management and reporting tasks, including:

- extracting data from the various mining packages;
- information gathering;
- designing reports; and
- spreadsheet building.

The time usually spent on these tasks can then be refocused towards improving the core activities of the mine site.

Automated processing of haulage information greatly enhances a mine operator's ability to validate a contract miner's (or contract trucking) material movement claims. In this case, Reconcilor has the capacity to save the mine owner both time processing the information and cost associated with recognizing invalid claims. For mining operations where this is an issue, the investment in an installation of Reconcilor is invaluable.

A major advantage of implementing Reconcilor is that these process improvements and potential savings can be identified and acted on. Without having to spend time on collecting and processing data, personnel can focus on analyzing the information and improving the way the mine operates. This ensures that the operation is optimized to provide the maximum benefits.

Improved resource modelling and mine planning

Reconcilor provides performance metrics on how the resource and reserve models perform against the actual plant results. This allows Geologists and Engineers to calibrate the estimates and importantly also, to identify areas where the models and predictions did not match the final outcome.

The constant feedback provided through Reconcilor, allows modelers and planners to adjust their methodology, which in turn results in enhanced predictions. The objective of any modeling and planning exercise is to accurately estimate how a particular material type will perform when presented to the plant. If the predictions can be consistently improved this greatly enhances an operation's ability to optimize.

These enhancements can have a significant effect on scheduling, blending strategies, stockpile strategies, plant recoveries and plant throughput.

Reconcilor allows personnel to respond quickly to material being sent to the wrong location or being double handled. Depending on the scale of the operation and the size of the problem, minimization of double handling and the optimization of material movement can result in significant improvements in plant throughput, resulting in a positive impact on revenue while at the same time also resulting in lower unit costs for ore haulage.

Revenue boosts and cost savings

Every mine site would like to increase their revenue and decrease their cost of production. There are few tools that can provide both of these results.

Reconcilor provides revenue boosts to operations in the form of increasing the quality of material delivered to the plant. When the processing part of the mining operation receives a better, more predictable product, it can increase performance providing bottom line results.

Reconcilor delivers cost savings to mine sites by automating a multitude of tasks carried out by staff at the end of reporting periods, and enabling them to make better decisions based on time-critical information. This effectively saves the operation money by having staff available to carry out their more productive tasks, rather than spend time chasing information and manipulating that information into a meaningful form.

Conclusions

Reconcilor is the world's first commercial software system specifically designed for reconciliation in the mining industry. It has been installed in mines targeting the production of diamonds, coal, gold, base metals, mineral sands, iron ore and uranium in locations throughout the world.

Based on the experiences reported from installations at these mine sites, Reconcilor has been shown to:

- help personnel clarify and standardize the reconciliation process;
- significantly cut the time staff spend at end of month completing reconciliation tasks;
- allow personnel to identify and resolve anomalies in the resource estimate, grade control, and mining processes; and
- provide personnel with the information needed to improve the mine's production results.

In today's mining world, the ability to provide information in a fast, transparent and accurate manner is no longer considered nice-to-have, it is a requirement. Moreover, this requirement has paved the way for reconciliation systems, such as Reconcilor, to demonstrate clear performance enhancements over more rudimentary manual methods. With this ability at the touch of a key pad for any company, reconciliation has now become automated and routine. In this way, areas of improvement can be defined when mines are under duress, or perhaps more importantly, in good times as well.

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