Reconciliation — Towards an Ideal Process

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ABSTRACT

Information obtained from a reconciliation system provides fundamental indicators to an operations performance and is often neglected as a key performance indicator when developing a business plan or mining schedule.

The cycle of exploration, ore definition, mining and processing within a company is constantly scrutinised both internally and externally as to the safety, environmental and financial performance of these activities with the operators judged on their performance on a periodic basis. However, it is not unusual for the reconciliation process to be given scant attention until a serious issue (usually a shortfall) occurs, at which point short-term solutions may be implemented which only serve to compound the original problem.

A robust reconciliation system takes time to develop and implement initially and must continue to evolve with time. The best systems are those where all the stakeholders in the ultimate outcome are involved in the design and accept responsibility for the validity of their component inputs. Output from the reconciliation process can be utilised to fine-tune all aspects of an operation once the underlying issues leading to a particular result are understood.

INTRODUCTION

The Australian mining industry is amongst the world leaders in fields of practical mining geology, resource and reserve estimation standards, open pit and underground mine planning software, three-dimensional ore body modeling and extractive metallurgy and the application of this expertise to the economic extraction of commodities.

The ultimate test of how well these skills are utilised is measured by the periodic evaluation of the product produced against a variety of yardsticks such as the production budget and current forecasts. In general, this evaluation often focuses on short term (monthly, quarterly), fiscal-type comparisons and may attempt some form of broad-brush evaluation against total ore reserve drawdown and depletion.

It is the authors' contention that little attention and effort is allocated to achieving the best possible result from the reconciliation process. This is surprising, given that it can be readily demonstrated that systematic reconciliation processes can assist with the short-term financial health of an operation and in the longer term, aid the determination of appropriate orebody modeling and performance parameters. In addition, once a result is obtained, this lack of perceived importance for the process is compounded by not returning the outcomes to the systems and individuals who provided the raw input data.

Further support for the lack of importance attached to the reconciliation process is shown in the level it attains in business plans or as key performance indicators. If reconciliation is mentioned at all, it is likely that it will rank within the lower 50 per cent of issues to be addressed.

It should not be a surprise then, if these assumptions are true, that operations without a systematic approach to reconciliation are unable to track where value is being lost (or added) to the overall result.

WHAT IS THE RECONCILIATION PROCESS?

In broad terms the reconciliation process can be described as five generalised subsystems:

- feasibility study,
- design,
- grade control/mining,
- milling, and
- reconciliation.

The latter three processes should all have periodic review processes built-in, in which the feasibility study becomes the benchmark on which all subsequent activities are judged, although as time passes and additional information becomes available, it may be decided to adopt a newer benchmark.

The linear sequence design – grade control/mining – milling, followed by reconciliation appears to be a common view of how all these subsystems relate, however an alternative view is that once a mine becomes operational, reconciliation is the core process on which all other processes and decision-making should be based or referenced to.

In detail, the reconciliation process is not a single process operating in a uniform manner in well-defined time frames. At any particular point in time, the whole process might consist of a variable number of materials-balancing subprocesses. These subprocesses often work to different time frames, for example, they may be essentially continuous (larger pits, the mill), periodic (mining of a particular stope) or erratic (delivery of high grade ore to the ROM).

RECONCILIATION ISSUES

In the author's experience and particularly arising out of discussions at a variety of sites, there are a number of common issues that relate to the reconciliation process.

Too complex

The process of periodic reconciliation of predicted metal content against actual metal content is often regarded as being too difficult to get 'right' and devolves to a simple process of dividing up the product produced in proportion to the total mill feed during the measurement period. There will be various reasons given for this perceived complexity, some of which are:

- there are too many variables to manage;
- a lack of on-site experience; and
- a lack of understanding of how a rigorous approach to reconciliation can benefit the whole operation.

In the majority of cases the overall reconciliation process is *complex* and it is difficult to establish with absolute certainty correct values for each data item in the process every time. Some of this complexity can be reduced or eliminated if each of the subsystems described above are viewed as being comprised of:

- data from a variety of sources, collected over varying time frames;
- information summarised from this data relating to the performance of the sources or processes being examined;
- knowledge gained over time relating to the inherent variations that may be present in the summary information and how this impacts on product value or performance over time; and

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- decision-making processes, based on the information collected, balanced against fiscal, mining and/or milling requirements.

To reach this level of understanding about the reconciliation process requires that all suppliers of input data and recipients of output product agree on the input requirements to the system, how this data may be permitted to vary, who is responsible for the quality of the required input data, how the system will be managed and how the results are to be delivered.

Using the mill as the final arbitrator

Inflexible reconciliation systems and partisan (or insular) points of view can lead to some interesting outcomes at the end of a reconciliation period, the more common of which observed by the author can be summarised as:

- The ROM is empty and the mill tonnage figures indicate a substantial shortfall in tonnes, yet both the geology and mining departments firmly believe that the mill figures are incorrect.
- High-grade ore (comprised principally of gravity recoverable gold) is sent to the ROM and processed through the mill with disappointing results. The mill figures are questioned despite the fact that the daily gravity, cyclone and tails results for the period in question do not indicate the presence of high grades;
- The mill reports a poor metal balance at month's end, indicating a substantial overcall by the mine. Bullion attribution to the contributing pits is decreased in proportion, this is despite the fact that pit Alpha is mining an enriched supergene zone and the mill responded accordingly on the days that this material was part of the feed. Alpha geologists believe they should have received a greater share of the available processed product.

These types of outcomes often reflect either unwillingness on behalf of the participants to accept responsibility for their part of the process or a failure to recognise and act on flaws in the overall system.

It is common for the mill to be blamed for any shortfalls, whereas the contrary view is that it should be considered as capable of providing invaluable information for use in managing all aspects of the ore reserve, grade control and mining process – it is after all, the largest, continuous sampling system on the mine site, providing regular quality information to the reconciliation practitioner.

Correctly allocating product to source

One of the principal issues behind correctly allocating product to source is being able to track material through the mining and milling processes.

In many mines, it is common practice to deliver ore to the ROM from multiple sources, eg different benches in a pit or different pits to the same stockpile in order to meet blending requirements for the mill. The situation is similar for underground mines where material from multiple stopes is fed to a common ore pass or where ore, which is loaded and trucked from discrete sources, is stockpiled as 'stope' or 'development' ore with no distinction as to its source.

The immediate impact that these delivery and stockpiling systems have on the reconciliation process is to smooth out the differences that may exist between the sources, which in turn tends to hide or obscure any issues that may exist. If blended stockpiles are relatively short-lived, it may be possible to accept this situation as a reasonable compromise, however when parts of these stockpiles remain unfed to the mill for extended periods, the more difficult it becomes later to identify the source of the material.

If it is at all practical, a mill feed system which incorporates stockpiling according to source, eg Stope A, Bench 300 of Pit B, will enable far greater control over the whole reconciliation process, which in turn will assist in managing issues as they arise and allow information to be fed back into the whole system in a timely fashion.

Value can only be gained from a reconciliation system by recognising that it is time-based and unless it has the flexibility to capture both short (eg production from a small pit or stope) and long term data, the decision-making process may be based on flawed information.

Site specific rules

In an attempt to work around the complexities that exist in the whole reconciliation process, sites with more than one ore source or ore type, or both, invariably evolve a set of rules, which attempt to model real or perceived orebody performance features, eg:

- Multiple pits and an underground feed source are fed to the mill during the month. Over time, the inherent variability of the underground ore has lead to the 'local rule' where the pits receive the metal they claim and the balance goes to the underground. This is despite the fact that one pit is known to have low recoveries. Underground believes it is subsidising the pits.

Rules may also be developed to meet the operational requirements of one part of the mine, but have unforeseen consequences when applied universally, eg:

- A mill treats both underground and surface ore, with the surface ore a mixture of oxide and transitional material. Mill moistures for the month average between seven to ten per cent, underground ore between 0.5 and two per cent and the oxide material varies between eight to 20 per cent and is also the dominant feed source. Mill product at month end is tonnes-grade proportioned between underground and the pit on a milled dry tonnes basis. Milled, dry tonnes are estimated based on moisture determinations made twice a shift by the mill, and this figure is applied to all feed for the day. The underground manager claims that the underground part of the operation is not receiving their fair share of the output.

Compromises such as these *site rules* may be quite legitimately applied if the consequences are well understood, ie in the above two cases the reconciled outcome disadvantages the underground feed sources. However, if the 'rule' is universally applied without periodic review, this may result in a biased view of how the ore reserve, grade control and mining processes for the source (subject to the rule) are performing.

The use of *site rules* is flawed as the existence of such rules means that either the ore reserves do not approach reality or that there are issues within the mining-processing-reconciliation systems which are either not well understood or are being ignored. Reconciliation systems, which are inflexible and are unable to change in a controlled manner or are not subject to periodic review, are the most likely to evolve site-specific rules to manage particular issues.

Changing reconciliation parameters

As a general principal, the results obtained from a reconciliation system should be used to tune the overall ore reserve, grade control and processing system over time, ie reconciliation is the reference 'hub' on which the performance of the other systems is judged. If the necessity for this approach is not well understood, the actual design and implementation of the reconciliation system will be poor or fragmented.

Change must be based on sound, agreed, principals, rather than as a reaction to outcomes considered 'poor' at the end of a reconciliation period. Changes based on this latter approach will result in the system itself being changed to match perceived reality, rather than the underlying cause of the problem being resolved or managed appropriately. Random changes to a reconciliation system can arise or be fostered in environments where:

- The system exists as a number of poorly integrated spreadsheets or similar computer programmes which their authors have evolved over time to suit specific requirements, which are not understood by others and can often only be operated by their developers. These spreadsheets can grow to be cumbersome and may be subject to continuous fine-tuning, often without other recipients of the information being aware that changes have been made.
- No single person has overall responsibility for implementing or delivering results from the system and just as importantly, the department heads involved in generating results for the system do not see themselves as joint owners of the process or the outcomes.

The net result of unheralded or poorly managed system changes, particularly at remote sites or at a single site in a multi-operation company, may be to introduce unexplained variances in standard reports or datasets, which in turn may lead to unwarranted conclusions being drawn by off-site recipients.

Self-fulfilling premises

Another reasonably common feature of reconciliation systems at sites that claim 'good' reconciliation results is that bulk and loose densities and truck factors are changed regularly in order to balance the books; in other words the system is always correct. This in turn means that the underlying reasons for these changes may not be addressed, and so the system self perpetuates.

Arbitrary, or unauthorised changes to the system such as these are easy to make, hard to monitor and if left unchecked, may eventually evolve into an accepted *site rule*.

System ownership

The practical implementation of a robust reconciliation process must be focused through as few as people as practical (preferably one person or a single position) in order for the system to produce information in a timely and consistent fashion. Given this view, it is important that all suppliers of information to the system accept that they are also shareholders in the whole process.

Failure by the key stakeholders to accept this premise of ownership eventually leads to a partisan approach to resolving issues and a fragmentation of the whole process. Conversely co-operative ownership of the system will mean that information derived from one part of the process can benefit other parts or may pre-empt issues growing disproportionately in importance.

A good example of this might be where the mine incurs excessive over-break in a pit or stope which in turn results in numerous issues in subsequent processes. Although the specific issues giving rise to the over-break may be attributed to mining practice or geotechnical issues, the outcome impacts on all parts of the reconciliation process, eg the diluting material may be a cyanocide, which subsequently impacts on recovery. In fact, close monitoring of daily mill data may point out this problem well before final shape of an ore block or stope is known. Therefore both mill and geological personnel should be able to provide timely feedback to the mine planning process to assist with managing the issue.

AN IDEAL RECONCILIATION SYSTEM

Many of the key components of an idealised reconciliation system have been raised in the discussion above. In summary, such a system would address, or be comprised of the following components and issues:

- The principal goal of a reconciliation system is to enable the on-going optimisation of all the key components of an operation, leading to the best possible utilisation of the resources on which it is based.
- All participants (input providers and output recipients) must understand the concepts, the aims, the required inputs, the logic to be implemented and the range of possible outputs of the whole system.
- Stakeholders in the system must accept that they are part owners of the whole and that the success of the system depends on a unified, cooperative approach to the issues.
- The system must be capable of adapting to changing circumstances; however change to fundamental system design parameters can only occur after consultation and discussion with all stakeholders.
- Successful implementation of the system relies on all participants being responsible for the quality and timeliness of their particular inputs.
- Results obtained from the system will be a function of numerous compromises and must be accepted as the best approximation, rather than as absolutes.
- Feedback to users must be in the form that they can utilise for their own purposes, eg section or departmental manager level.
- Overall responsibility for the management and operation of the system must be focused through an individual or a single position, which in most cases would be the mineral resources manager.

Collectively these components should provide tools to the geologist, miner and metallurgist which will enable them to evaluate their short-term production results in the context of optimally extracting the resource over the life of the mine.

The volume of inter-related data involved in such a system described above means that solutions meeting these criteria are best implemented using either a specifically tailored relational database or some form of data-mining technology. Given the growth in corporate intra-net based knowledge systems, it is quite possible that the elements of a sound system already exist within the corporate structure and remain unrecognised or are yet to be placed in a standardised format.

CONCLUSIONS

A brief examination of the potential roles that a reconciliation process can play in the tuning of an operation shows that it should be considered as a principal operational performance indicator, capable of summarising the collective health of the overall system.

There is nothing new or radically different in the observations presented above; in fact many of the individual components of a good reconciliation system exist and are in use at most mineral processing operations, however, what does appear to be lacking in discussions on reconciliation processes is the overall understanding at both a site level and corporately of how the individual components relate to each other and how this information can be used to benefit the whole operation.

ACKNOWLEDGEMENTS

I am indebted to those geologists, engineers and metallurgists, in particular Andy Purvis, who have helped shape these ideas over time. The referee who provided practical and thought provoking comments is also acknowledged.