

Production Accounting & Inventory Management: a Digital Transformation Approach in Mining Operations

WHITE PAPER

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INTRODUCTION

Inventory of materials, from in situ ore to finished product, is the most important asset of any mining company. Yet many companies still manage, report, and reconcile their inventory using spreadsheets and other manual processes. This leads to inaccurate information and causes a significant time lag in reporting.

Leading mining companies are now adopting technologies and operations management software solutions to gain real-time visibility into their inventory to reduce losses, improve recovery, maximize throughput, and enable better decision-making to ultimately improve profitability.

According to PriceWaterhouseCoopers, the market capitalization of the Top 40 Miners declined by 37% in 2015, meaning that many are marked below their book values and any gains made during the mining boom have now been effectively “wiped out”¹. And with analysts divided as to whether we are at the bottom of the market or simply entering a heightened period of volatility, mining companies the world over are seeking new ways to maximize value.

Caught in the crossfire between declining demand for commodities, volatile pricing, and increasing operational costs, mining companies must shift their focus from maximizing throughput to improving productivity and cutting costs. High cost producers are already at risk of being pushed out of the market.

While many have already undertaken significant cost-reduction measures – cutting back on new capital projects, divesting non-core assets shutting down marginal operations – mining companies are now turning their attention to operational excellence and wringing more productivity from their existing assets. As noted by PriceWaterhouseCoopers, these new productivity initiatives are ‘unchartered territory’ for miners as they bring with them a fundamental change to business – people, process, procedures – and longer-term paybacks.

As the most important asset of any mining company, inventory is not surprisingly high on today’s agenda. From the ore in-situ to the finished product en-route to a customer, it is imperative that inventory be managed and reconciled to provide an accurate, timely indication of company production performance.

For years, inventory has been managed through a plethora of spreadsheets and other manual practices – often leading to inaccurate information and a significant lag in reporting. With operational excellence strategies focusing on achieving sustainable improvements of key performance metrics (KPIs), market leaders are adopting technology to more accurately and efficiently manage their inventory.

Chief Information Officers (CIOs) in particular should pay attention to this new trend as it sees the move to managing inventory using integrated IT/OT systems; where ERP systems utilize real-time data from the production environment. Benefits realized with this shift to automated production accounting and inventory management include:

- Reduced material losses
- Improved materials management and recoveries
- Improved ad-hoc analysis and process diagnosis
- Improved throughput
- Improved decision-making
- Improved business improvement initiatives

This whitepaper will highlight these benefits in more detail, including case studies of how market leaders are using digital technologies to increase productivity and profitability with accurate, real-time visibility of their inventory and a holistic view of their business performance.

UNDERSTANDING INVENTORY

Outside of its people, inventory is the most important asset of any mining company. Inventory is most commonly defined as the entire value of materials held by an organization to:

- Support production e.g. raw materials, work in progress
- Support activities e.g. maintenance, consumables
- Sell i.e. finished goods.

As a key indicator to company performance, an accurate and timely understanding of inventory is imperative for any mining operation. And this is achieved through the application of inventory management and inventory accounting systems.

Inventory management refers to the activities employed to maintain the optimum amount of each item, be it raw materials, consumables or finished product. It also covers the quantity and quality of material at any point of time in the supply chain. The objective is to provide uninterrupted production and sales at a minimum cost.

Inventory accounting is the process of identifying, measuring, reporting, classifying, verifying and summarizing the value of an organization's inventory. The objective of inventory accounting is to understand the organization's largest and most valuable asset, at any point in time and any point in the value chain.

Accurate understanding of inventory is necessary for businesses to run successfully and efficiently. Not only does it affect working capital, but also the ability for companies to respond to changing market conditions. Knowing where inventory is located means organizations can take advantage of additional sales opportunities should demand increase and this can have a significant impact to the bottom line.

Why production accounting is important to inventory management?

Yet inventory management is just one part of the story. Production accounting systems must also be in place to monitor the process itself.

Production accounting systems interpret and communicate information for all processes and methods employed to transform tangible and intangible goods. It provides information on resource availability, the means employed to finance these resources and the results achieved through their use.

The objective of production accounting is to provide an accurate measurement of each key production process within the supply chain over a period of time. The concept of production accounting applies equally to the world of mining, especially as market leaders adopt a "mining with a manufacturing mindset".

"Contextualized data can then be used to improve stock control, address bottlenecks and optimize value chain performance".



Production accounting captures movements as they occur, and aggregate at a defined frequency (e.g. daily, by shift, or by month) and at a defined period (usually monthly) a reconciliation occurs to align the measurement to the agreed level (e.g. survey or stock count). These survey measurements are defined as more accurate measurements, when the reconciliation is performed; the differences are applied as unaccounted gains or losses. Such reconciliation can be implemented as a bulk adjustment or factored across all movements depending on the defined process of the organization.

By linking inventory management procedures with production accounting companies are able to gain an accurate view of inventory over time and throughout the production cycle. This contextualized data can then be used to improve stock control, address bottlenecks and optimize value chain performance.

The role of metal accounting: applying quality to quantity

In order to achieve the most accurate determination of inventory across the supply chain the quality of the material at any point in time must also be considered. This is realized through the processes of metal accounting and metallurgical balancing.

Metal accounting, as defined in the AMIRA P754 Code of Practice for Metal Accounting & Reconciliation³, monitors the valuable metals from the time ore is broken until it becomes a saleable product. Process data pertaining to the metals of economic interest is collected from various sources and transformed into a coherent, report format to meet specific reporting and planning requirements.

In simple terms, metal accounting is about applying quality grade to the quantity.

The determination of metal quality and quantity throughout the production process is known as metallurgical balancing. This by definition is determined through measurement, analysis and computation of the magnitude of each component of interest within each section of a process flow sheet. It is achieved through both:

- Primary accounting - measurement across an entire plant
- Secondary accounting - measurement across each section of the process flow sheet

Metallurgical balancing can also include waste minerals e.g. residues and tailings, which are balanced for reporting and environmental compliance of an operation.

An important component of metal accounting is reconciliation. This is done by ensuring that two sets of records are in agreement at the end of a reporting period and discrepancies are readily identified and addressed. In mining, this reconciliation process applies to semi-finished (work in progress) and finished products.

By providing up-to-date information on inventory quantity and quality, metal accounting helps better control the metallurgical process. This can lead to improved production throughput and ultimately increased revenue and profitability.

It is also critical in providing key information about stock on hand for planning production and logistics to move materials from one location to another e.g. concentrate stockpile to smelter.

INVENTORY MANAGEMENT TODAY

The importance of production accounting & inventory management within the metals, mining and minerals industries cannot be understated. Yet many companies are still managing inventory using spreadsheets, paper records and other manual methods.

While spreadsheets are cheap to implement and offer benefits such as familiarity, the flexibility to manipulate numbers, and ready accessibility, they also have their drawbacks. For instance, spreadsheet proliferation leads to human error and inconsistencies between departments and reconciliation processes.

Spreadsheets evolve over time. They are become more and more complicated. These intricacies mean spreadsheets become very 'one person' dependent and difficult to handover should the owner of the sheet leave. And the inherent complexity means the spreadsheets quickly become too large and unmanageable.

Additionally, each department will often have their own spreadsheet, or series of sheets, to meet their own reporting requirements. So when data is reconciled it leads to conflicting numbers and confusion as to which sheet is more accurate. There is no "one version of the truth". Additionally, with paper records often still utilized as data truths, this issue is further compounded.

However, with all these concerns, the biggest issue with managing inventory using spreadsheets is actually reconciliation. Why? Because of time, visibility and ultimately flexibility.

To reconcile a plethora of complex spreadsheets takes time. It's an exercise that can take many days, once a month. And that's the only time that inventory is accounted for. Meaning that numerous mining companies are currently running their businesses using a static snapshot at the reconciliation point and not live inventory data throughout the month. Inventory accounting in this instance is only about financial reporting for the ERP system.

While this provides some level of understanding, it cannot provide the data required to remain competitive in today's challenging market. The true value of inventory accounting lies in being able to actively monitor and manage inventory in near real-time. Real-time inventory accounting allows miners to become more agile and responsive to meet supply chain demand. This enables companies to optimize process operations while taking advantage of market opportunities for increased profitability.



THE FUTURE OF INVENTORY MANAGEMENT

The future of inventory management comes in the form of integrated Production Accounting & Inventory Management software packages, such as Ampla Operations Management software from AVEVA.

Automating data capture through your control system, or historian, is the first step in the transformation journey to modern inventory management. Allowing you to not only access information in near real-time but to also help ensure data integrity across the entire network. But the real power comes when you overlay business information onto the operational framework through a manufacturing operations management (MOM) system.

Sitting in Level 3 of the ISA-95 framework, MOM systems provide an interface and digitalisation of information management between the control level (PLC and SCADA) and the business level (ERP), or "shop floor to top floor". Enabling data to be readily accessible at all levels of an organization, not just to the spreadsheet owners. By enabling this IT/OT convergence, MOM systems play a unique role in being able to help visualize and contextualize data. This added perspective helps users to not only identify material losses but also where, when and why these losses are occurring, and ultimately how to minimize them.

For instance, production accounting & inventory management systems provide visibility to areas where data collection may be an issue; such as biases in weightometers, or when level sensors are out. By dramatically reducing the reconciliation process these issues can be identified and resolved much quicker than previously possible.

The time saving principles of software also apply to metal accounting and metallurgical balancing. For instance, it is very hard to measure the quantity (tonnes) of material in a tailing stream due to the high level of liquor (non-solid material) using traditional methods. However, using an automated sampling and analysis process you can use a two-or three-product formula to calculate the tonnes measurement. A dedicated software program can make this process so much simpler by systematizing the collection and processing of the measurement data.

Because software systems enable processes to be measured in a timely manner, companies are now able to obtain visibility across their entire supply chain. Enabling them to not only optimize performance within a process silo (e.g. crusher, conveyor) but across the end-to-end value chain. Having a single version of data truth, or "digital thread", means that conflicts over which data is accurate are minimized, or even eliminated.



Real-time management using a single digital thread

With software now providing a trusted source of data to all levels of the organization, production accounting & inventory management systems unlock a realm of possibilities when it comes to process improvement and optimization.

Role based permissions means that users can now access accurate, timely data that is pertinent to them. Improved data capture means that reports can easily be generated for multiple views of the same information. And by contextualizing data and presenting it in easy to read reports and dashboards, software systems help empower better decision-making throughout an enterprise.

For instance, by providing superior visibility to Plant Managers, production accounting & inventory management packages allow a true determination of plant inputs and outputs, and better, more informed decisions about production efficiencies. Managing and tracking inventory and material movements across the entire value chain means better control over production and costs because you know exactly where your stock is at any given time. This also improves accuracy across the entire value chain as up-to-date information is readily transferred to other systems such as planning, maintenance and optimization systems.

Another key benefit of software systems over spreadsheets is the definition and enforcement of business process rules. Best practices such as rigid check in/check out processes means that an audit trail is automatically built into the software for any manual changes.

Business rules can also be applied to automatically capture and categorize process events such as equipment starting or stopping, or even during periods of slow-running. This reduces manual data input and allows users to perform root-cause analysis in near real-time; enabling the rapid prioritization of maintenance, new equipment and even changes to operating procedures.

In addition, leading production accounting & inventory management software packages support ISA-95 compliant inventory management material classes. Features such as Contributors, Weighted Average Movements (WAM), Material Constraints and Material Movement Look-up help improve the visibility into work-in-progress inventory and gain significant performance improvements by identifying and removing process bottlenecks.

With business rules managed through the software, there is a new level of consistency in the application of rules and data manipulation between different operating divisions. Take reconciliation for instance, if there is a discrepancy in weight between a truck and a crusher weightometer, then the business will choose to accept the more accurate reading (usually that of the weightometer). In addition, the truck movements are defined on the crusher output over a defined period. This allows visibility to be brought back to the hourly period and the discrepancy pinpointed to the actual moment in time when it occurred. So reconciliation happens when the discrepancy occurs, not after the fact at the end of the month as in manual systems.

Production accounting & inventory management systems enable the visualization of all movements – both input and output – that have contributed to the location, stocking point, stockpile or work centre.

Mining with a lean manufacturing mindset

As market volatility continues to play a crucial role in the operation of mining companies many are looking to other industries to provide a competitive advantage. Many have already identified the principles of Lean manufacturing and just in time stock as key principles to help deliver process improvements and improved profitability.

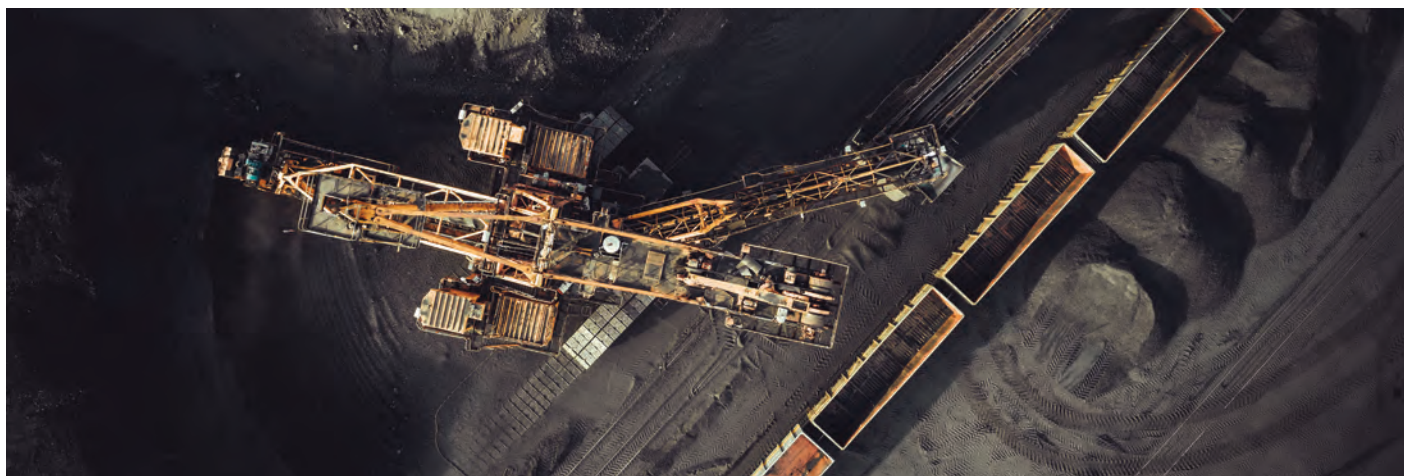
Stemming from Toyota in the 1990s, Lean manufacturing is a management philosophy focused on improving the value-adding components of production and reduce waste. The key is to minimize non-value-adding work, overburden and unevenness in the production process.

As detailed previously, software systems ensure timeliness of reporting by capturing data in near real-time and enable detailed root cause analysis. Additionally, these software systems are able to provide a snapshot of inventory levels at a particular moment, and to track these over time. By having this historical record of inventory movements, companies can identify bottlenecks or areas of overburden in the production process.

Production accounting & inventory management systems help reinforce a culture of continuous improvement by enabling methodologies such as Plan, Do, Check, Act. Enabling users to enhance the way they:

- Plan – by understanding where the process constraints are at any given time means that you can manage the value chain holistically and plan better across the entire organization
- Do – enabling the execution of the single plan that is approved and optimized from resource to market, including planned maintenance schedules
- Check – which areas of your plant are underperforming and concentrate on these areas to lift recoveries
- Act – with recovery calculations available in real-time you can quickly identify if something is affecting your process and implement corrective actions.

Whether it's Plan, Do, Check, Act or another Conformance-to-Plan initiative, mining companies are constantly striving for sustainable improvements. Software is a key enabler to allow market leaders to more accurately manage their inventory quantity and quality across the entire supply chain.



CUSTOMER CASE STUDY

A large iron ore miner in Australia required a production accounting & inventory management solution to effectively manage material levels across their resource to market value chain.

The iron ore mine identified a number of key business goals that needed to be addressed as part of the inventory solution including the ability to:

- Track material in terms of quantity, quality and contributors from the mine blocks, through ROM stockpiles, processing plant, logistics networks to the port and finally ship loading.
- Store ore movement transactions, calculate the quality and quantity at inventory locations.
- Provide a mechanism for shift Supervisors to confirm shift data accuracy and the Superintendent performing daily validation.
- Allow users and systems to make informed decisions based on the accurate data collection and reporting of material movements and inventory location information.
- Enable the mines to deliver a product based on customer requirements – in terms of quantity and quality.
- Meet all internal and external regulatory and statutory compliance obligations.
- Create shipping documents.

Ampla Operations Management software from AVEVA was selected for this purpose because it offers a commercial off the shelf (COTS) solution to this problem.

Expected Business Benefits

The successful deployment of the Ampla Operations Management inventory operations management capabilities outlined above will deliver the iron ore customer a range of business benefits including:

- **Reduced material losses, improved materials management and recoveries**
Delivering a more accurate picture of inventory – quality and quantity – at a given moment, and at any point of the value chain means that the customer can better manage material throughout the process.
- **Improved ad-hoc analysis and process diagnosis**
Capturing and maintaining inventories in terms of pre-processing, product and waste material will help support improved quality management and reconciliation.
- **Improved efficiencies and throughput**
Enabling the customer to operate an efficient mining operation where performance can be managed through the accurate recording and reporting of data.
- **Improved decision-making and business improvement initiatives**
Increasing the predictability of mining operations and enabling the customer to respond quickly to changing market demands. Understanding exactly where inventory is located means improved responsiveness and increased profitability.

Conclusion

As the mining industry contracts and commodity prices remain volatile, the increased focus on operational excellence is driving the market to transform manufacturing operations by digitalization of business processes. Market leaders are driving such transformation to achieve improved visibility, performance and profitability across their supply chains from pit to port. One important contributing aspect is the digital management of inventory and integration of ERP systems with accurate, real-time data from their production process. A commercial of the shelf mining operations management system such as Ampla Operations Management software from AVEVA, helps to achieve these benefits with a short time to value and fast ROI.





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1, 2. PriceWaterhouseCoopers, "Mine 2016: Slower, lower, weaker... but not defeated" <http://www.pwc.com.au/publications/mine-2016.html>

3. AMIRA P754 Code of Practice for Metal Accounting & Reconciliation http://www.amira.com.au/web/site.asp?section=projects&page=projectdetails&ProjectLink=2607&Source_ID=1

About AVEVA

AVEVA is a global leader in engineering and industrial software driving digital transformation across the entire asset and operational lifecycle of capital-intensive industries.

The company's engineering, planning and operations, asset performance, and monitoring and control solutions deliver proven results to over 16,000 customers across the globe. Its customers are supported by the largest industrial software ecosystem, including 4,200 partners and 5,700 certified developers. AVEVA is headquartered in Cambridge, UK, with over 4,400 employees at 80 locations in over 40 countries.

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