# IRON ORE TRACKING AND OPTIMIZATION SOFTWARE[1]

*Robert Jonas* [2]
*Neil Freeman*[3]

**Abstract**
Mining companies need to optimize their production chain and provide information better and faster to their marketing and enterprise headquarters. One solution is to track material properties and flow throughout the entire production chain, from mine to port, and from mine to marketing. Visibility of the production chain allows for analysis of working capital, work in progress and inventory holdings is critical for businesses seeking to optimize operations while maintaining flexibility to meet customer demand. Through the integration of the production chain information with ERP systems, the logistics and production chain are highly visible allowing near real-time analysis of inventory and working capital and enhancing operational responsiveness. This paper will discuss a software solution developed to address this need and that has already been deployed to several iron ore mine sites. The solution: automatically tracks material movement from mine to plant to port, maintains and visualizes transactional production data such as plant inventory, material quality, composition, and production activities.
**Key words:** Iron ore tracking optimization software.

## MONITORAMENTO E OTIMIZAÇÃO SOFTWARE PARA MINÉRIO DE FERRO

**Resumo**
Companhias de mineração precisa a optimize sua corrente da produção e forneça a informação melhor e mais rápida a suas principais escritórios. Uma solução é seguir propriedades e fluxo de material durante todo a corrente de produção, de mina ao porto, e de mina ao marketing. Visibilidade do corrente da produção permite a análise do fundo de maneio, trabalho em andamento e inventário é crítica para as empresas que pretendem otimizar operações, mantendo ao mesmo tempo flexibilidade para satisfazer a procura dos clients. Com a integração do informação sobre corrente da produção com sistemas de empresa, a logística de corrente da produção é altamente visível que permita quase em tempo real a análise do inventário, fundo de maneio, e para reforçar a capacidade de resposta. Este trabalho irá discutir uma solução de software desenvolvidos para responder a esta necessidade e implantada em vários sites mina de minério de ferro. Detalhes sobre o como a solução: faixas automaticamente o fluxo de material para a mina de planta de porto, mantém e visualiza produção dados transacionais como inventário, materiais qualidade, composição, produção e atividades.
**Palavras-chave:** Minério de ferro; Optimize; Monitoração; Integração da informação

[1] *Technical contribution to the 3rd International Meeting on Ironmaking, September 22 – 26, 2008, São Luís City – Maranhão State – Brazil*
[2] *Business Development Manager for Mining and Metals, Honeywell Automation, Phoenix, AZ, USA*
[3] *Marketing Manager for Mining and Metals, Honeywell Automation, Perth, WA, Australia*

## 1 INTRODUCTION

The purpose of this presentation is to discuss the challenges that mining and material movements operations are faced with and how an integrated approach to management of the information can assist the operations and supply chain management. This is done through a discussion on the challenges associated with the mining supply chain. There are certain things that if controlled well (the business imperatives) will empower the operations to better deal with the inherent heterogeneity of the ore. That is, turning a heterogeneous ore body into saleable "product" encompassing client specifications on size, quality, tonnage and delivery dates in the most effective way possible. One of the aspects that will help is to manage information effectively through a better understanding of the information needs (Mining Information Needs). These needs will provide a certain set of requirements (the desired state) which if fully satisfied can provide significant benefits to an organization.

This paper will discuss the needs for a software solutions and the solution developed and its application to iron ore mining and logistics. Refer to typical depiction of system in Figure 1, keeping in mind that a solution may typically include several iron ore systems depicted in the figure.

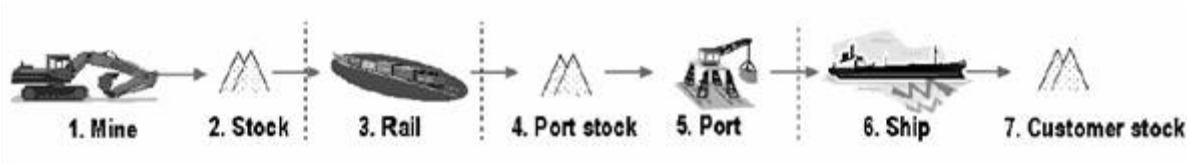


**Figure 1.** Iron Ore Mine to Port

## 2 METHODS

The method deployed are a result of research into the needs of several iron ore manufactures during the period of 2005 through 2008, as well as understanding of the needs of mining companies as a result of extensive experience of the authors and their employers. The author's research and knowledge have resulted in methods that take into account the needs of the mining operation, port operation, and marketing and logistics organization. The needs include the ability of these users to easily make meaningful use of the information. Furthermore, the solution should also take into account the needs for implementation of software as well as the sustained support of the software.

The mining operational needs for optimizing software are defined as:

- Take a non-homogenous raw material and turn it into a homogeneous product at a better than average profit margin. The method is one of "Variance Management" throughout the mining, extraction and shipping process.
- Creates an opportunity that can allow flexibility in dealing with operating and infrastructure constraints. The major opportunity for the iron ore producer is blending of ores for increased throughput and recovery while managing the product grade, operating, and infrastructure limitations. Miners who manage variance will have a competitive edge, delivering better product mix, on specification, for optimal price and lower cost.

The challenges of a software solution for optimizing ore delivery and logistics should:

- Fill sales orders, ship on time, get paid early

- Knowing what, where and how much inventory there is to sell
- Knowing when you can sell
- Pull production to maximize high margin spot potential
- Accurately reconcile production against product shipped

The port operations needs for this software solution are:

- No wait time on ships, minimizing demurrage
- Fulfill Marketing Orders, using just-in-time manufacturing principles
- Minimize material handling and maximize straight to ship
- Optimize blend timing and minimize quality variance. Following the idea of “do it once, do it right”
- Timely and accurately reconcile received vs. shipped
- Accurately reconcile EOM and minimize time it takes to achieve.

The method deployed must address three key business imperatives for a mining and logistics, reliability, optimization, and continuous improvement. Each are these are discussed in the sections that follow.

## 2.1 Reliable Processes

The need here is to focus on operational flexibility yet be repeatable. This is really about ensuring that if you want to do something that you can. Thus if you need to mine from a certain area you want to be sure that the equipment is available to be able to do so. While this may seem obvious, often little coordinated thought is put to the information processes that support the operations. Thus if an miner wants to take advantage of spot pricing in the market place, they want to be sure that the product is available to be sold. For example, one mining company ordered a ship for transportation of 60,000 tonnes of product that they believed was available only to find that whilst it was registered on their books the material was not actually there. This is not only costly but a good example of an information process that was not reliable. The method must address the business imperatives and challenges for reliable efficient processes inn the following areas:

- Accurate Estimates
  - Resources are predictive of recovery
  - Reserves use valid/realistic economic parameters
  - Unit rates of performance are tuned by reconciliation
  - Systematic bias can be identified and calculated
- Accurate Measurement
  - Instrument quality, calibration/testing and redundancy
  - Quality sampling and analysis
  - Quality execution
  - Real-time compliance management and exception-based variance follow-up
  - Managed by “information-rich” decisions
  - Tested through accurate measurement

## 2.2 Optimized Assets

Having reliable processes is certainly a means of being able to supply what is required, which may provide some flexibility in the operation. Thus we can now start to take advantage of this flexibility by optimizing the use of the assets through better planning and scheduling. For instance good blend optimization will provide a means

of ensuring that quality is not oversupplied (that is giving away material) or undersupplied (resulting in a cost penalty). Some key points of asset optimization are:

- Constraint Management
  - Quality scheduling comes from accurate knowledge of capacity and constraints
  - Optimal decision making when circumstances change (e.g., equipment breakdown)
- Scenario Development
  - Multiple “what if” scenarios are run for routine production schedules to test for latent capacity
  - Increases the understanding of what control business performance (under what conditions does the “bottleneck” move)
- Tuned Through Reconciliation
  - Improved estimation (removal/accommodation of bias)
  - Update on the resource capacity (unit rates of performance)

## 2.3 Embedded Continuous Improvement

The systems must be such that they enable improvement. For example, while it may be thought that an Excel spreadsheet based system provides this flexibility it is very hard to control what is in a spreadsheet. All too often in organizations once the original spreadsheet designer moves on then his knowledge is lost. The replacement tends to start again because they don’t understand the spreadsheet and feel that they can do better. This means that significant effort may be expended just to replicate what has previously been done.

Accurate measurements against plan and against schedule are essential for achieving financial targets, continuous improvement, and fiscal/governance reporting. To get more effective supply chain processes the ability to schedule effectively is vital as it permits increased throughput and recovery at lower cost. For example scheduling is heavily dependent on accurate measurement around overall material, location and asset constraints. Good planning and scheduling will enable continuous improvement if the method addresses the following key points:

- The resource estimation and capability models must be continuously tested through reconciliation
- Comparative statistics with reconciled data provide the basis for analysis from a definitive data set (one version of the “truth’)
  - Plan/Schedule vs. Actual
  - Estimated vs. Actual
- Badly "performing" ore blocks or measurements are tuned
- Provides a sound basis for inventory measurement as feedback to scheduling and increases confidence in JIT operations
- Assist in the identification of constraints
- Retargeting scheduling parameters for optimizations, permits increased throughput and recovery
- Analysis, action and review of the process response (learn what works under what circumstances)
- Automating the data manipulation to allow more effort in analysis business imperatives and challenges for reliable efficient processes inn the following areas.

The information needs for tracking and optimizing an iron ore production chain is summarized in Figure 2. The Mine Reserve (Mining model) and the Resource (Geology model) model represents the long term model of the mine, in particular the amount and qualities of ore remaining. The Grade Control (Blast Block model) is a short term model of the mine production. As its name suggests its main function is to model the ore being mined to ensure that the production meets company and customer requirements. The production information is used to review and refine the Mine models. This is an iterative process and is generally one of determining the differences and explanation thereof. The review may be performed by the Mine Planning Group. Information is extracted from the Mine Planning system, mine production system, survey systems, sales system etc. to allow comparisons of the Mine reserve to planning and to production data. As it is time consuming to extract this information these reconciliation factors are rarely calculated (perhaps monthly) and not used for improvements to planning and scheduling. That is they are used for explanation purposes only whereas these represent a great opportunity for improved scheduling.

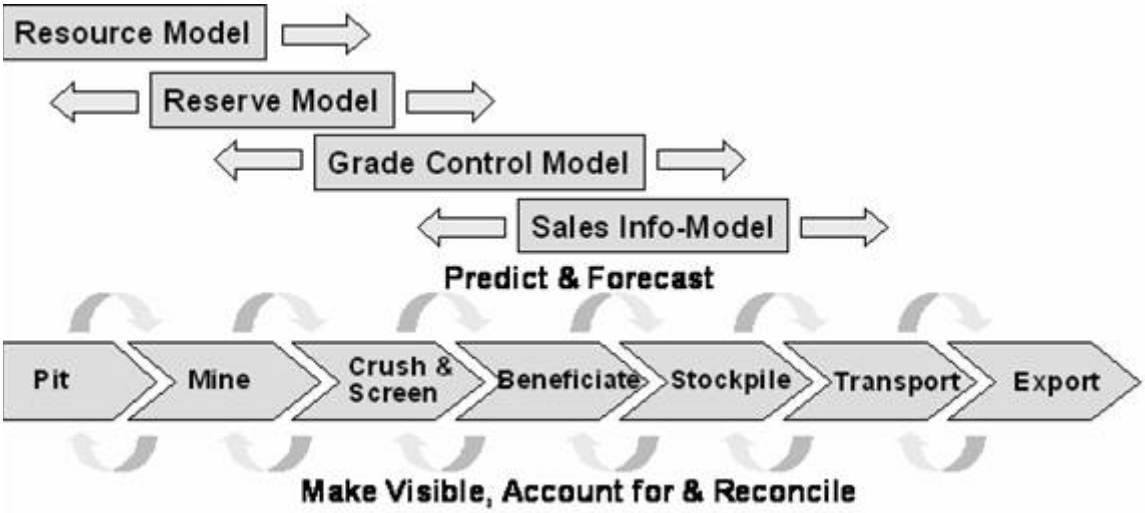


**Figure 2**. Representation of Mine and Logistics Information Flow

In some operations it is just simply a matter of having unexplained errors between one operation and the next. Of course if these get too large they must be explained, but this is done after the fact and is based on 'gut feel' or political reconciliation. It is better to reconcile these errors continuously such that they are attributed to the areas most likely to cause the error. In this way errors are always explained in a way that contributes to continuous improvement.

## 3 RESULTS AND DISCUSSION

### 3.1 Commercial Solution

The solution developed handles a wide variety of mine and logistics operations, and is applicable to metal processing as well. The solution was designed to be used for those industries that include the following:

- Any materials handling process
  - Where the material is related to 'batches'
  - Requiring the tracking and tracing of information (batch attributes)

- Examples:
  - Mining logistics (ore source to shipment)
  - Port blending and shipping operations
  - Stockyard movement operations
  - Casting and processing operations

The design approach taken follows the model typical for Manufacturing Execution Systems roughly follows the model by the MESA organization.[1] As shown Figure 3, the needs for analysis is shown in circled. What is important to note is that the MESA model shows the need for analysis as a separate and distinct function within a structure that manages data and information as well as communicates with data sources and enterprise business systems.

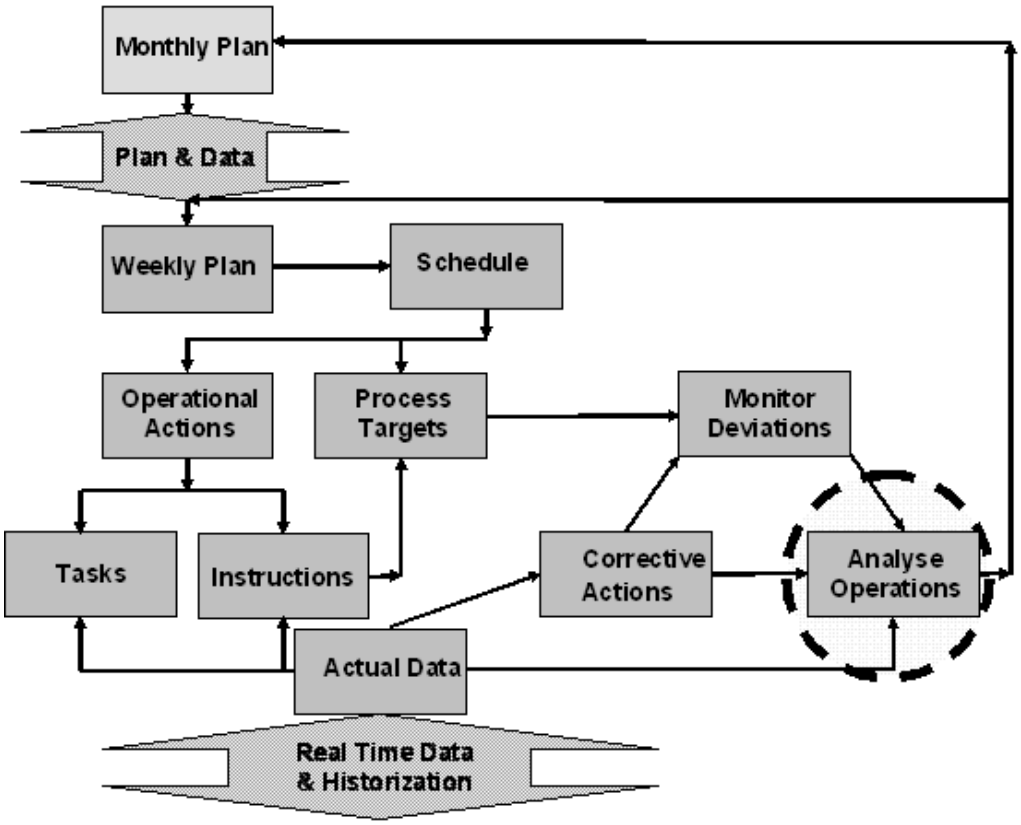


**Figure 3**. MESA Model for Implementation of MES.

The practical implementation of the tracking and optimization software is shown in Figure 4. The software developed by Honeywell has been given the name of Material Tracking. As shown in the figure, data is electronically read (interfaced) into the system from historians, lab information systems, databases. In addition, interface data tables can be used for that data not conforming to standard data protocols (e.g.; OPC, and historian formats). These are processed and can be even used indicate events (end-of-batch, or indication of movement) or can be used to generate commands. The Ore Tracking function was specifically developed to detect changes in ore movements, say from silo to train. Generally speaking, most ore movements are calculated from known information of transportation methods and their delays. The information is presented in an easy-to-use fashion that is rich data environment using event views, data tables, and mixed data trends & tables. Also data can be manipulated and extracted for further analysis.

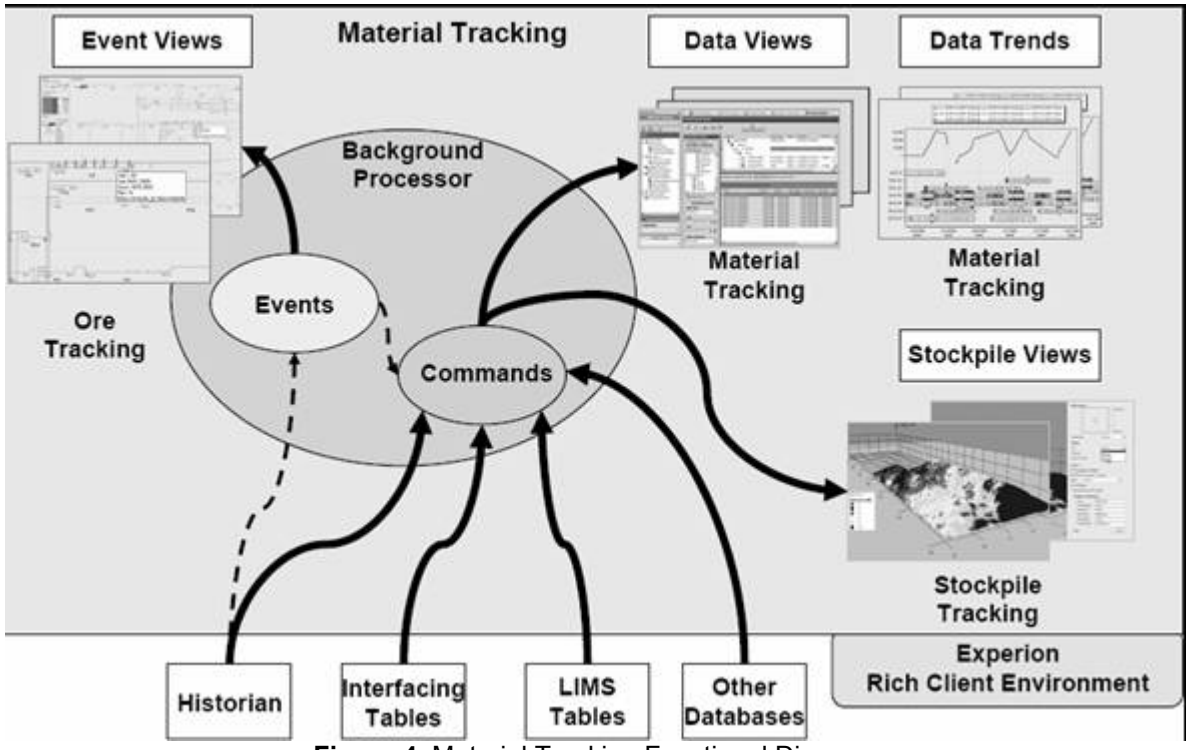


**Figure 4**. Material Tracking Functional Diagram

The Material Tracking system, when used as part of a commercial MES, provides the desired characteristics for the optimizing the iron ore mine and logistics. These characteristics include:

- Single trusted data source across the operations;
- Consistency in terminology and data structures;
- Traceability of product from ship to mine;
- Integration with control systems and other data sources;
- Integrated Blend Planning system
- Integrated production (tonnage and quality) reconciliation system
- Integrated stock adjustment system allowing for verification by physical stock takes at various intervals
- Single source of data for business systems
- Open environment for regular internal and external audits and reviews to ensure compliance with all aspects of the laid down procedures.
- Commercial-of-the-shelf (COTS) software, addressing the need for system support for the long-term through the concept of configuration and not custom programming. Furthermore, path for continuous improvements can be realized from a larger community of users driving product improvements.

The essential underlying feature of Material tracking is the information rich view of the ore flow and its associated properties, including customer order information. Key to the success of Material Tracking, is the easy access to this information in a meaningful way. Refer to the example shown in Figure 5, where real-time instantaneous data is cross-plotted with movement transactions via a configurable charting facility.

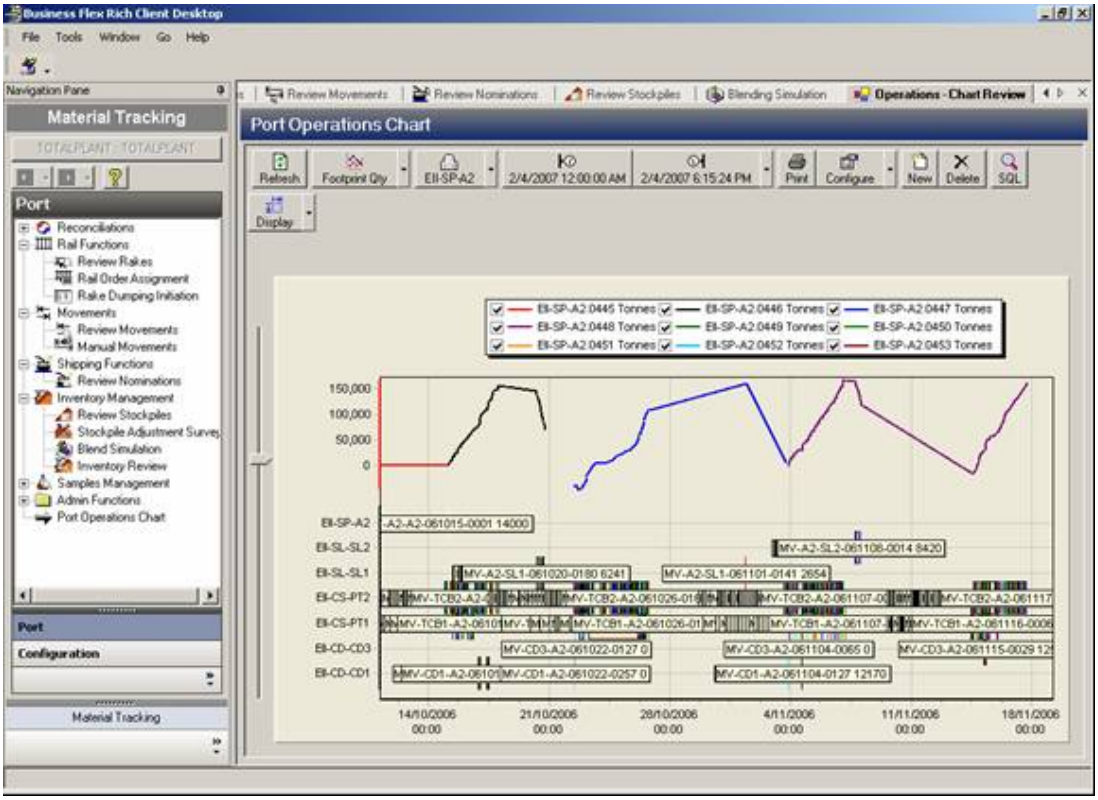


**Figure 5**. Example Port Operations Chart from Material Tracking Software

## 3.2 Results

The initial applications of this solution by Honeywell in 2007 and 2008 have proven a wide spectrum of benefits, as seen in Figure 6. These include reconciliation of production reporting and resource models, optimization through integrated scheduling and ore tracking. In addition, by improved capabilities in information access and speed, a foundation has been set to provide improvement.

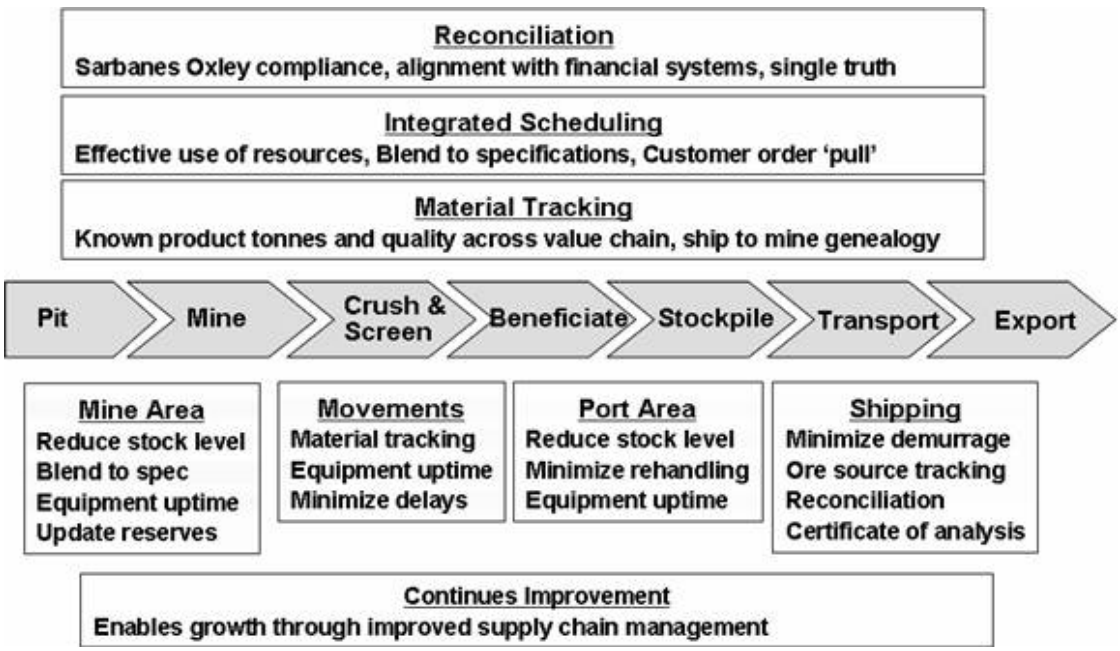


**Figure 6**. Example of Benefits from Material Tracking Software

## 4 CONCLUSIONS

Tracking and optimization of iron ore can be done through the use of commercial-off-the-shelf software. Software can be used to deliver business performance enhancements in the key areas of:

- Improve Process Reliability, through enabling technology to manage the entire production chain from mine to port.
- Optimize Assts, by managing the production chain to known and visible constraints, developing optimal scenarios for production, and tuning production or resource models to enable optimal long term planning.
- Continuous Improvement, by providing a mechanism to monitor and manage asset in terms of production, grades and orders.
- Sustainability, through the use of commercial-off-the-shelf software, epitomized by the concept of configure not program

## REFERENCES

1 MESA, MES Explained: A High Level Vision. MESA Organization, in published Document, 1997