

MRO Inventory Optimization is now Considered Business Critical



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I. Introduction

While most manufacturers invest significant time, energy and resources into an Enterprise Asset Management (EAM) strategy, Maintenance, Repair and Operating (MRO) inventories have, for the most part, remained a misunderstood and mismanaged portion of a company's asset base. In fact, there exists enormous potential for establishing a competitive advantage by optimizing purchasing and management of MRO inventories.

Companies that have begun to understand the unique characteristics of MRO inventories are using science-based optimization methodologies to their advantage. The direct and measurable result has been plant capacity increases along with significant cost savings through improved plant fill rates (percentage of orders that can be met by available stock at the time the order was placed) and utilization of new-found discretionary cash.

Effective management of MRO inventory is challenging and complex. Traditionally, the management of MRO inventory has revolved around manual and subjective ordering, often based on flawed historical information. The inferior plant fill rates experienced by the majority of manufacturing companies are evidence of this vulnerability. A large percentage of the time, maintenance personnel are unable to respond to equipment breakdown due to stock outs in MRO inventory.

To combat stock outs (fill rates), companies have traditionally increased spending on MRO materials. For the most part, however, companies have lacked the analytical tools and the expertise required to measure and manage MRO inventory behavior. They do not know with certainty the optimal Order Point (OP), Order Quantity (OQ) and Lead Time (LT) for every SKU, especially in real time. With incomplete information, companies purchase too much inventory and purchase items that will never be used in the future. In essence, a large part of every company's operating budget is wasted on excess inventory.



A new inventory management tool based on proven algorithms is now available to optimize MRO inventories, and comply with new, more stringent corporate governance requirements. Management and purchasing staff now have complete visibility and can take confidence in a truly independent yet “in-house” driven best practice solution.

II. Maintenance, Repair and Operating (MRO) Inventories

MRO inventory definitions can be varied depending on your point of view or type of business. For the purposes of this paper, MRO takes on the more conventional definition of Maintenance, Repair, and Operations characterized as a class of parts and materials purchased by a business to adequately stock inventory levels in support of its internal operational requirements. The accounting world views MRO as “indirect material”, whereas “direct material” actually forms a part of the finished product. At the core, MRO is about effectively managing spare parts inventory availability for critical production, facilities and fleet equipment that businesses depend upon daily. The challenge is keeping just enough material on the shelf to maintain high levels of equipment availability, uptime and service management while not breaking the bank.

The straightforward solution to maintaining equipment uptime is to simply maintain more parts in inventory. That way, whatever the service level requirement may be, you have the inventory on hand – whether you need it or not. But keeping stockrooms filled with excessive amounts of spare parts comes with a real cost to the business. Money tends to rapidly get tied up inside the stockroom with unnecessary purchases, shelves filled with infrequently used parts, and dead inventory that never gets used (but the carrying costs live on). MRO inventory can have a powerful impact on what the bottom line of a business (see customer case study in this paper) might look like. But properly managed, it can also create significant value through efficiency and competitiveness for the entire organization.

Inventory management decisions can be overwhelming when determining how much and which inventory items should be replenished, how much safety stock should be kept, what quantities should be purchased, how inventory should be classified, and what considerations

need to be made for older equipment because replacement parts are scarce or possibly discontinued. Chances are that as an MRO inventory manager, your management team is constantly looking to you to improve financial and operational performance year over year through:

- Improved availability of parts
- Reduced number of inventory items
- Reduced annual spend through lowered inventory costs
- Shortened time to repairs

There are many factors involved in making sound decisions about MRO inventory that are based on individual company business goals and objectives. The advent of inventory analytic tools is helping businesses remove the high stakes from the decision process and significantly reduce the financial exposure and risk to the business. Algorithms are becoming increasingly accepted in many industries where immense quantities of data can now be analyzed. “No human being can work fast enough to process all the data at a certain level” is a quote from a recent article explaining the new, wide-spread use of algorithms.¹ The article specifically addresses how “Manufacturers and retailers use them to fine tune their supply chains”.

1. “Business by Numbers”, The Economist, September 15, 2007

III. MRO Inventory and the Supply Chain

One definition of supply chain management is: “Supply chain management spans all movement and storage of raw materials, work-in-process inventory and finished goods from point-of-origin to point-of-consumption”. Although this paper focuses on describing techniques and methods to specifically manage MRO inventory, the two are inexorably connected. Companies invested in the supply chain can’t afford to forget or ignore the aspect of streamlining spare parts inventory management – holding costs, obsolescence and parts availability. The result of having comprehensive tools to provide accurate information about spare parts inventory will help businesses to objectively assess MRO inventory status, costs and stocking policies, thus reducing their cost of managing the supply chain.

Large supply chains can usually be characterized as complicated mazes of different application functionality and process interdependencies ultimately connected together to achieve productive and profitable results for the business. In order for an inventory management and optimization tool to effectively work in this environment, it must possess a high powered capability to non-disruptively and seamlessly extract data from this system, perform detailed analysis and deliver timely results to optimally stabilize and adjust for demand and procurement needs. Similarly, if employees bypass the supply chain systems and try to manage things manually, then even the most expensive systems will provide an incomplete picture of what is happening in a company's supply chain.

Managing supply chain performance should take into account a balanced inventory management approach that can maintain essential inventory levels without creating an overburdened system of excess/dead inventory and related costs. However, businesses must first be prepared to proactively undertake certain activities before fully introducing inventory management and optimization solutions into supply chain labyrinths that are expected to yield cost savings and efficiencies to the business. At a minimum, the following should be considered:

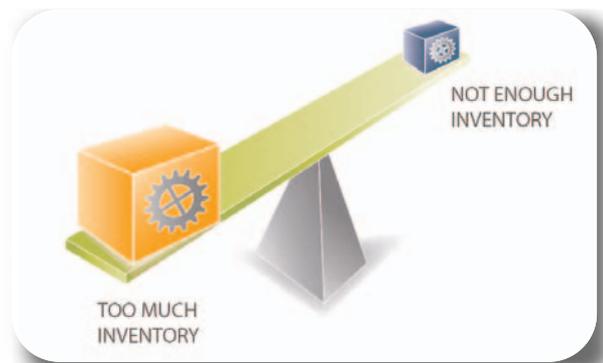
- Repair and optimize existing MRO inventory ordering processes
- Perform data scrubbing to combine and reconcile enterprise-wide data
- Decide on a streamlined and consistent inventory reporting mechanism
- Institute manageable service levels related to product availability
- Establish practical inventory management policies (replenishment, disposal, etc.) designed to stabilize costs

Successful implementations of inventory management and optimization solutions within multifaceted supply chain implementations will necessitate the need for data integrity, scalability and straightforward integration for solving small or large supply chain problems. Only then will enterprises be able to expect the highest levels of business, financial and operational excellence and performance from their inventory management systems.

IV. MRO Inventory Optimization?

Any discussion about inventory optimization must start by considering "risk". Risk exists everywhere, but especially in the availability of a repair or maintenance part. Failure to have the right part at the right time can lead to consequences as drastic as plant shut-down and, accordingly, the risk needs to be handled effectively. It must be:

- Identified
- Quantified
- Mitigated
- Monitored



MRO inventory optimization enables companies to achieve a desired fill rate (usually 95% to 100%) when servicing requests for parts from maintenance personnel. It is achieved using the algorithms to calculate optimal Order Points and Order Quantities for every SKU item in inventory on a monthly basis.

The goal of inventory optimization is to eliminate common problems:

- Stock outs
- Incorrect reorder points
- Incorrect reorder quantities
- Out of stock inventory (and why)
- Excess inventory
- Obsolete inventory
- Inaccurate lead times
- Low turnover rates
- Ongoing purchase of dead or declining-use inventory

And to enable:

- High levels of equipment availability
- Critical spare enhancement
- Spare sharing
- Other SCM initiative improvements such as scrubbing and leveraging

MRO optimization improves cash flow by reducing over-purchases of rarely used MRO inventory spare parts, consumes excess inventory appropriately, and maximizes productivity by reducing plant downtime. This adds to a company's bottom line and improves



Inventory Optimization Opportunities

V. How MRO Inventory Optimization is Achieved

First, a brief understanding of the unique behavior of MRO inventory is presented here as a background to illustrate why optimization is such an elusive endeavor using traditional forecasting means:

Traditional MRO Inventory Behavior

In most MRO inventories, only 5% of items are frequently used. Traditional business systems can indeed forecast their usage with sufficient accuracy. However, it is the remaining 95% of items that cause the problems. These items are infrequently used and sit in a company's inventory only to be used a few times per year, or perhaps never used at all. It is these infrequently used items that cannot be accurately forecasted using traditional means. Interestingly, on average, only 2.7% of items make up 80% of dollar throughput.

Until now most companies have been applying traditional forecasting methods when purchasing MRO inventory items. As a result, with virtually every purchase transaction, costly errors are made. No adjustments are made to min/max levels on items that are increasing in demand; while the need to reorder items that are declining in demand are renewed. The outcome: low fill rates and unnecessary high inventory investments.

The Inventory Optimization Process

The optimization process seeks to make the right inventory items available to customers in the appropriate quantities such that customers can obtain needed material in a timely manner. A secondary but important goal of the optimization process is minimizing the costs of providing MRO materials to these customers. Of course, the customers for these MRO materials in this context are operations and maintenance people in the plant or facility being served by the inventory investment. A wide range of items is needed to keep plants and facilities operating at the appropriate levels of efficiency and safety. Inventory optimization involves first setting target stocking levels at the plant and then developing a set of procedures for each item so that timely and cost effective material replenishment takes place.

Setting target stocking levels and developing replenishment procedures are implemented as the result of several key decisions:

- Whether or not an item will be physically stocked at the plant
- Consideration of customer service requirements (criticality level)
- The target average investment in inventory for each item
- Direct and indirect consideration of replenishment handling costs

All of the above decisions require the setting of target levels of performance and depend, in part, on the analysis of past demand for the items to be stocked at the location in question.

Safe and Efficient Operations

Primary consideration is given to customer service levels. These service requirements and the criticality of a repair part to the continued efficient and safe operation of the plant or facility will determine what is stocked at the location. The *allowable inventory investment* is *secondary* in that it may be allowed to grow within limits in response to customer requirements, availability in the market, lead time for replenishment and the need to reduce replenishment handling costs.

Optimal Fill Rates

Customer service level goals are most often stated as the desire to fill a target percentage of all stock line items requested by customers, quantity complete, and off-the-shelf at the time the customer request is made. The *target service* level also known as “target fill complete rate” must be set by management and is usually in the range of 90% to 100%. The approach used makes extensive use of two distinct sets of algorithms that estimate the least biased value of the next quantity demanded. The first set of algorithms is used for items demanded frequently enough that an underlying statistical distribution can be identified. The second set of algorithms is used for items that are not demanded frequently enough to identify an underlying statistical distribution. Determination of which set of algorithms used for a particular item should be entirely automatic.

The Right MRO Investment

The limits placed on the inventory investment are usually stated in terms of management’s desire to achieve a *target rate of turnover in the inventory investment*. Often, an item’s lead time will determine that a minimum amount of the item must be stocked in order to satisfy demand at a plant or facility during the interval between orders.

- Using the most appropriate lead time is a key determinant in achieving the right MRO investment
- Defining which parts are “critical” to the operation is also essential in managing the risk of stock outs
- Recent advancements in algorithms have taken ordering mechanisms into the realm of “best practice”
- There needs to be a basis for auditing changes from a “Base Month” in order to measure success
- KPIs with respect to MRO investment should lead to a list of actionable items

VI. Who Can Benefit from MRO Inventory Optimization?

Ideal candidates for employing inventory optimization methodology are companies with the following characteristics:

- Large number of MRO items
- Subjective KPIs related to MRO performance
- Low inventory turns (2.5 or less)
- High stock out rates MRO inventory values of \$2M and above with large numbers of SKUs

On average the quantitative impact of these conditions are as follows:

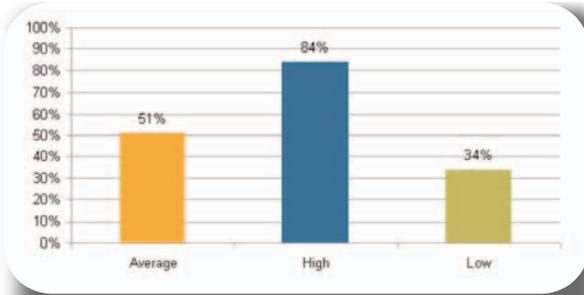
- 22% of the time the maintenance person leaves the storeroom without the proper quantities or material
- 9.7% of material purchased today is in excess of one year’s supply
- 5% of material purchased today will never be used
- Less than 3% of “excess material” will be returned to original supplier

The questions that these conditions raise are the first step toward rectifying the issues:

- Which MRO inventory items should be purchased in greater quantity, to enable a plant to operate more safely, more efficiently and at higher production?
- Which inventory items are at risk of stock out due to OP/OQ that aren’t sufficient to meet fill rate requirements, and what is the root cause of the event?
- What accumulated inventory items have the highest value of recovery? Of those, which items can be directly returned to the manufacturer? And which items can deliver returns via investment recovery specialists?

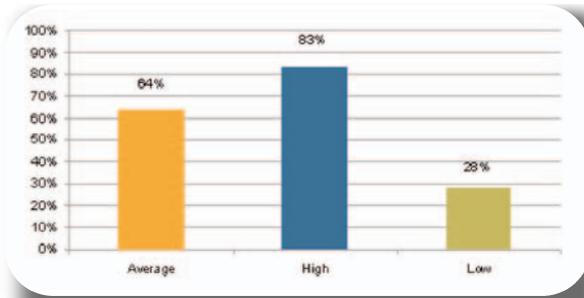
Most companies are surprised to learn that the information required to formulate the answers already exists in the past transactional data of their MRO inventories. Extracting this information and analyzing it enables businesses to set OP and OQ or Min and Max to achieve a specified fill rate at the lowest cost.

Moving Inventory Investment as a Percentage of Total



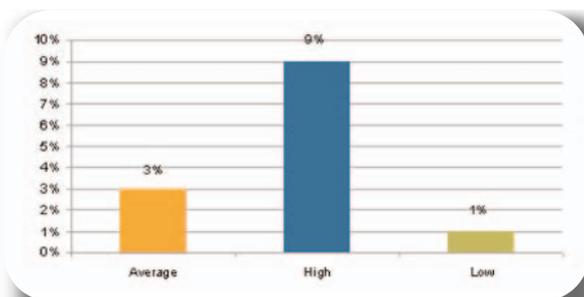
An average of 51% of the value of the inventory did not move in the period studied (approximately 36 months).

Percentage of Non Moving SKUs



Over 64% of the inventory items did not move in the same period.

Percentage of SKUs that make up 80% of Dollar Throughput in Stores



Only 3% or less of the inventory items constitute 80% of the annual dollar throughput.

Web-based tools enable better tracking and monitoring of Key Performance Indicators (KPIs). They also promote continuing process improvement.

VII. Expectations: Early Deployment, Timeline and Value Measurements

This single business tenet must hold true: **Without increased productivity, there is no credibility and even the best conceived SCM solutions are doomed.** No matter the extent of cost savings, or the pursuit of best in breed programs, if productivity is in question, there will be no deployment at the asset level in the “trenches”.

Inventory optimization should be the first supply chain initiative employed by any asset intensive corporation. In all cases, it can be achieved while ERP systems are being deployed, upgraded or changed. By optimizing first, the redundant inventory is flagged and omitted, duplicates are removed, lead times confirmed, and most importantly, fill rates are achieved. The required inventory budget can be automatically projected over three years.

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SCM initiatives such as scrubbing, leveraging, consolidated pricing, VMI (vendor managed inventory), consignment and critical part sharing all benefit from employing optimization first, or at least in parallel. Fewer data points (SKUs) need reviewing, analyzing and servicing. Optimization methodology should also present constant benchmark and KPI feedback to measure not only its performance, but also the performance of the related best practice solutions.

VIII. The Integrated Solution:

IHS xIO™ and the Client’s ERP/EAM

So how does a large enterprise with hundreds of millions of dollars tied up in MRO inventory achieve the right balance between replenishment and costs? How can the enterprise take back control of spending, improve ROI, and guarantee MRO availability? Simply, they implement IHS MRO Inventory Optimizer powered by xIO. By building this integration, businesses combine modern, scalable and extendible architectures that can immediately create opportunities for improvement in inventory management processes, as well as deliver significant financial savings to the business in a very short period of time.

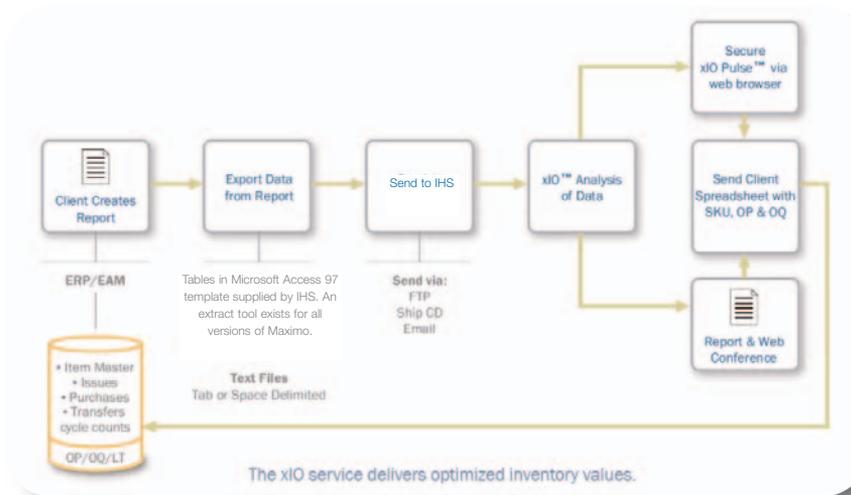
The xIO solution can be implemented with any ERP/EAM system. It has been validated by IBM and is considered “Ready for Tivoli Software”. The process of implementing the xIO is culturally non-disruptive and delivers dependable and defensible inventory level recommendations tied to financial results regardless of the inventory size. This success is easily measured with metrics and KPIs that are resident in each solution. The integrated solution addresses the problem of inventory management and optimization as follows:

1. Transactional data is extracted into a specified file format and exported to the xIO analysis system.
2. The xIO service processes and analyzes the data to scientifically measure transactional changes in MRO inventory.
3. The xIO service immediately responds to increases or decreases in demand for MRO items; recalculates optimal Order Points (OP), Order Quantities (OQ) and Lead Times (LT).
4. New optimized OPs and OQs are delivered back and entered into the relevant ERP/EAM system.
5. Performance is tracked.

available when it is needed can’t be overestimated. A reliable inventory optimization tool can help to determine what is available, thereby increasing fill rates and reducing stock outs. This is one of the benefits realized from implementing the xIO solution.

Because enterprises are multi-site and multi-org, the use and power of the xIO reminds us that technology does matter when addressing inventory management and optimization. Information availability and delivery cannot be taken too lightly. Customers receive a full web- and standards-based architecture that is anywhere/anytime accessible. With the xIO, customers immediately save on capital and remove much of the IT involvement, since the xIO is purely a hosted service. And in the middle, customer options to transfer transactional data can range from email, to FTP, to implementing consistent and automated online commerce capabilities.

The xIO solution has been created to help businesses in complex, asset-intensive industries with high inventory investments that support a wide variability of assets.



The xIO service delivers optimized inventory values.

This emphasizes the need for a solution that can regularly and accurately optimize MRO inventory using current and comprehensive transactional data from an ERP/EAM system, and powerful analytics for calculating and reporting critical MRO inventory values that support the operations and overall supply chain of the business.

The xIO is “multidimensional” in that it addresses fill rates and critical material availability from a user definable class analysis

format. An item’s criticality level is

determined by the client, and service levels are adjusted to reflect the importance of the item no matter it’s monetary value or physical attributes. Criticality is actually managed more successfully when xIO rules are applied to critical items. Whether or not an item has been determined to be critical, by running it through the xIO, the customer will still realize 80% of the optimizing value. The xIO can do the “heavy lifting” in understanding the client’s criticality process.

Research reveals that large enterprises can easily have over 150,000 SKUs but usually a very small amount of this inventory can really be shared. So, in global businesses where assets play a critical role in the operations, ensuring that MRO inventory is actually

The xIO tracks asset-related materials and their usage. All transactions involving materials are recorded, allowing for real-time knowledge of materials status so stockroom managers can easily identify and track transactions that move items into or out of inventory, or from one location to another – streamlining the part and materials management process.

The xIO Rules Engine provides a way to document, preserve and implement best practice in an entirely consistent, repeatable and error-free manner. Checks are performed on data received, after the data import and again after the xIO processing. Thousands of data checks are performed each month, and each may be designed for a specific client. The client can also use the Rules Engine to build and customize additional KPIs that enhance decision making capability.

The capacity to see the impact of the xIO and measure changes in inventory levels from a Base Month is a unique and valuable component of the solution. It is a key monitoring tool in tracking the progress toward an optimal inventory level. xIO has an auditing capability to measure current results against the client’s established base month, for important parameters such as inventory investment, volume increases, compliance and stock outs.

In summary, the IHS MRO Inventory Optimizer powered by xIO helps companies strike the right balance of MRO inventory within the supply chain to meet maintenance demand, attain service level agreement metrics, adhere to regulatory compliance requirements and free up cash flow.



The integrated solution is able to:

- Have the right part in the right quantity at the right time
- Deliver purchasing decision support
- Determine the outcome for separate facilities
- Provide corporate level results – verifiable at the line item level
- Clearly present KPIs in a web-architected environment
- Calculate and confirm accurate lead times
- Produce custom actionable items lists
- Direct upload of results into the user’s ERP/EAM
 - Properly set minimums & maximums
- Establish Order Points & Order Quantities
- Provide analysis of infrequently used and/or dead inventory Identify items in danger of stock out – proactively
- Provide a flagging system that reduces stock outs and presents a root cause when they do happen
- Ensure the consistent self-audit of every transaction/result
- Deliver, on average, a minimum of 10% cash flow return and a significant increase in customer-specified fill rates

Deployment is uncomplicated:

- A workshop is held to adjust over 33 parameters in order to fine tune and localize a deployment
- The set up is easy, non-intrusive, doesn’t require outside consultants and doesn’t disrupt the corporate culture.
- Data format templates are supplied – data is entered into the template forms from existing ERP/EAM systems (2 hours – usually job-stream)
- Data is supplied to IHS for analysis over secured web transmission Completed analysis (recommended OPs and OQs) are returned to client for automatic upload
 - Completed within 3 days of month end
 - Posted to the xIO Pulse for client review on a line item basis over a number of parameters, 24/7

The client typically achieves:

- 10% increase in material availability within four weeks
- Average cash flow savings of 8% of MRO inventory value in the first year (heavily weighted in the first 3 months) and 2 - 5% every year thereafter*

* Averages based upon xIO clients

The xIO improves inventory management, replenishment and optimization through increased fill rates, lower inventory investments, and eliminates the purchase of items today that will become dead in the future. The solution's success can be confidently measured in its ability to streamline the supply chain and allow the business to realize maximum cost improvements.

Timeline of a Sample Company



IX. A Customer Study: Reducing Inventory Investment While Re-Deploying Savings to Maximize Facility Uptime

The Client: Boise Paper, a Division of Boise Cascade
 Boise Cascade, headquartered in Boise, Idaho, manufactures paper, engineered wood products, plywood, lumber, and particleboard and distributes a broad line of building materials, including wood products manufactured by the company. Boise is a privately held company, majority owned by Madison Dearborn Partners, LLC, a private equity firm with extensive experience in the paper and forest products sectors.

Boise Paper (wholly owned) provides a wide array of high-quality products including label, release, office, food packaging, commercial and financial printing, security and converting papers. Boise offers many recycled-content papers and is committed to sustainability in their stewardship practices. The company is the third-largest manufacturer of uncoated free sheet in North America with 1.6 million ton capacity, and is proud of its safety record.

Boise's Objectives

Boise Paper's production facilities consist of 4 integrated pulp and paper mills (MN, WA, LA and OR) as well as one recycling plant in Alabama. Boise's key business strategy is to improve its competitive position in specialty and premium paper grades. In recent years, the North American Pulp and Paper Industry has been under financial pressures due to foreign competition. Companies with the most efficient and profitable operations have continued to prosper.

Boise management is tasked to find creative and nimble innovations on a worldwide basis. It was this management philosophy that led the Boise International Falls team to canvas the maintenance (MRO) inventory optimization sector and arrive at the xIO website. Management's basic premise was to improve facility productivity in a cost effective manner. In short, inventory was to be significantly reduced.

"We were looking for a means to a greater impact at reducing inventory without adding resources. We have experienced a positive impact in both cash flow and material availability"

– Janis M. Koerbitz C.P.M.
 Purchasing Agent
 Boise White Paper, L.L.C.

Deployment and Collaboration

xIO™ was implemented under a "Phase 1" scenario at International Falls MN in May 2007 (all Boise plants employ Maximo 5.2). The process required one site visit of 2 days duration and a number of follow up calls and emails. If proved successful after a 3 month trial, Phase 2 would be undertaken with the rollout to the remaining 4 facilities across the country. Boise set a very aggressive inventory reduction goal to be achieved within the year.

Initial results were so positive and convincing that the Boise corporate team elected to move to Phase 2 and implement all locations, less than one month into Phase 1. Within seven business days, xIO trainers had visited all the Boise facilities, implemented the xIO and conducted user and management workshops, fully deploying the functionality of the service.

Boise's management have developed confidence in the xIO to the point policies have been constructed. One of the mill locations requires written explanation if xIO recommendations are manually overridden by plant personnel. Another is a reinvestment formula of one dollar reinvested for each three saved. xIO Analysts and management team have continued to provide Boise management with support at all levels, from the evaluation of a single line-item, to evaluation of corporate impact. The success of this initiative is due in part to the collaborative yet "best practice" nature of both the Boise and xIO people.

"xIO has provided an objective and data driven analysis of the current replenishment process. This analysis identified opportunities, provided solutions for optimizing inventory, and challenged the mill personnel to think differently about inventory stocking levels."

– Monty Bryant
Maintenance Services Manager
Boise Cascade

The Results

Very positive results have been recorded on a corporate-wide basis where adoption rates have been most aggressive; however, the strongest results have been attained at International Falls, where deployment has continued over the longest period of time:

- 75% of Boise's aggressive inventory value reduction target set for this year has been achieved in 6 months
- Recognized 80% of the yearly investment was allocated to only 3.6% of inventory items
- Program ROI was reached in less than one month
- No facility has lost time due to the Inventory Optimization initiative
- Accurate lead time determination has led to a decrease in item stock outs

- Successful results tie directly to a facility's recommendation adoption rate initially, 8 hours per month were required to manage the project – now managed by exception
- Corporate Management has complete and concise visibility across all plants, down to the line-item level

X. Summary

Through the xIO, inventory managers can now make sound decisions by assessing the financial impact of inventory levels on the business. This assessment knowledge can be used to improve areas like work/job planning and service levels.

An inventory management and optimization solution must dynamically adjust for changes in business operations and recalculate the impact on fill rates and cash flow savings. A solution that brings powerful inventory management and analytics together will create an effective system to significantly improve decision making, business process effectiveness and profitability.

Note: All numerical values and percentages presented in this paper are based on xIO calculations and historical results. xIO™ is a registered trademark of XTIVITY Inc. (an IHS partner). All rights reserved.



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