

# Lean on MRO throughout the A&D Supply Network

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## INTRODUCTION

Globalization is altering the competitive landscape for MROs. Emerging markets in Latin America and Asia are rapidly gaining market share while many North American and Western European MROs struggle to contain costs and remain competitive. In fact, Latin America and Asia are expected to increase their MRO revenue by 88% and 61% respectively through 2014<sup>1</sup>. In contrast, North America is losing about nine points of global market share through the same period. Thus, the pressure on North American MROs to eliminate waste and maximize quality is increasing exponentially.

But *business as usual* cost containment models won't eradicate the growing disparity between the North American, Western European and low-cost emerging labor markets. In fact, in order to restore market share and sustain their competitive positions in the global marketplace, North American and Western European MROs must evolve their operations and organizations—now!

## ***Redefining Battle Strategies for Today's MROs***

Particularly within the aerospace and defense industry, MRO operations are plagued by excruciatingly long maintenance cycle times, which are exacerbated by a legacy systems infrastructure that offers little if any visibility into available parts information, maintenance schedules, service level agreements, asset performance data and maintenance forecasts. In an atmosphere of massive cost reductions, manual processes, and both an aging weapons cache and workforce, MRO operations have become a bastion of margin-eroding inefficiency. At the root of this inefficiency lie several causes including:

- Technology obsolescence of parts and systems
- Industry consolidation and diminishing sources of skilled labor
- Siloed in-service engineering and depot maintenance functions
- Antiquated project contracting and performance measurement programs
- Disjointed information systems architectures

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<sup>1</sup> ["Finally! MRO Value on the Upswing" by Frank Jackman, \*Overhaul & Maintenance\*, April 2004.](#)



## ***Fighting the Last War***

*Before the information superhighway, MROs were stuck in a documentation gridlock.*

Prior to pervasive computing, integrated IT networks and applications to support specific business requirements, document-dependent MROs relied upon paper-based manuals, drawings on whiteboards and technician memories to manage their operations.

While these paper-based maintenance manuals provided standardized instructions for repairing specific weapons systems, the after service reports were written ad-hoc by individual service techs. But what these technicians possessed in mechanical prowess, they often lacked in process documentation expertise. As a result, the after service reports were rife with inaccuracy, ambiguity and subject to the next service tech's interpretation. In addition, this dependence on paper was time consuming, costly and often inaccurate—prolonging turn times, undermining quality and adversely affecting the weapons system's mission readiness.

Because MROs were so heavily reliant upon paper-based information, the market soon provided a variety of one-off verticalized software solutions for managing these vast amounts of documentation. While document management systems provided some automated functionality, these applications were not integrated into any centralized business system across the MRO enterprise and thus, failed to deliver the necessary maintenance functions beyond an electronic documentation database.

As time went on, technology automation evolved, and enterprise resource planning (ERP) applications entered the marketplace. OEM's began using ERP systems for managing their back office operations and manufacturing supply chains. However, seeking to continue this automation beyond the back office and into the service operations, many MROs and software applications providers tried to extend these ERP systems from materials planning up through maintenance scheduling.

While this thinking may have seemed pragmatic at the time, the fact is that ERP systems were not designed to perform maintenance functions and required enterprise-level integration to execute these verticalized functions. Instead, ERP systems were designed for materials planning within a manufacturing environment—where planning processes would start from a zero baseline, and schedules were based on the time and expense required to build a product. The procurement and assembly of components, parts and systems

were then added in a methodical and repeatable order, rendering this type of planning process, for the most part, to be consistent and predictable.

In contrast, maintenance scheduling does NOT start at zero. Rather, it starts at some “plus” point along the asset lifecycle—and every repair instance is typically unique and to a high-degree unpredictable.

### ***Power by the hour and the genesis of PBL***

In the early years of MRO, pricing for maintenance was based on the time it took to complete a repair and the cost of materials that were used. This type of *time and materials* accounting, while seemingly straightforward, did not provide any incentive for MROs to accelerate their turn rates or guarantee any particular level of mission readiness.

Because of the unpredictable nature of maintenance planning, asset owners and operators demanded more control over the MRO process and wanted to replace the time and materials (T&M) accounting with a more predictable, fixed pricing model. In concept, this transition made logical sense, since fixed pricing guaranteed a set price for a particular asset’s repairs. However, this pricing quickly became geared toward MRO service providers NOT taking a loss, and as a result, MROs would price aging aircraft repairs according to the worst-case scenario in order to recover any losses if the repair costs had been underestimated.

The next generation of service agreements to emerge on the MRO landscape was known as *power by the hour*<sup>2</sup>. This type of agreement guaranteed an asset would be up and running for a specific period of time, or that the asset would be mission-ready for a defined number of miles.

Power by the hour also guaranteed a recurring revenue stream for MROs, as it generated monthly maintenance payments, regardless of whether the asset needed any maintenance or not. Similar to many of today’s subscription service models, operators enjoyed the predictability of knowing exactly how long their weapons systems would be available for missions. However, power by the hour contracts were often based on performing the least amount of maintenance possible and did not provide any material incentive for

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<sup>2</sup> [“Power by the Hour” is a registered trademark of Rolls Royce.](#)

quality improvements or the long-term viability of the weapons system.

Over the course of MRO history, shop-floor processes have not changed much over time. But the IT environment has changed significantly. Where there was once little if any collaboration or access to reliable information, today technology automation capabilities are able to capture and support timely, accurate and robust information flow.

However, even as MROs begin to leverage technology to automate the capture and dissemination of their data, these data often sit in individual spreadsheets or siloed databases that are not integrated into any centralized system. As a result, the data is not as reliable as it could be, engineering data is not of the quality it should be, and the analytics that support the continuous improvement of the MRO operation are based on insufficient or inaccurate information, and thus, thwart the efforts toward predictive maintenance.

## ***Out of the Business As Usual Trenches***

Symptomatic of these legacy conditions, the current day-to-day dynamic within MRO operations involve a number of challenges that impede asset performance, service productivity and operating profits. Often, these challenges become increasingly difficult to surmount because of:

- Service providers and maintenance operators who rely on antiquated technology to address emerging issues of aging weapons systems and their associated service requirements
- Limited engineering resources which cause programs to *react* to critical problems rather than to *anticipate* them
- Undocumented performance metrics that distort expectations and inhibit continuous improvements
- Loosely defined service level agreements that delay deliveries, increase maintenance costs and threaten customer retention
- Manual-intensive information systems that do not function effectively in real-time

## ***Tactics for Future Mission Readiness***

### **Performance Based Logistics**

While the primary objective for operators and MRO providers is to convert unscheduled maintenance to scheduled work, it is estimated that on average, about 60% of the maintenance on military aircraft is unscheduled.

Thus, in an environment rife with unpredictability, traditional MRO operations must rethink how they diagnose and repair aging weapon systems faster, drive costs lower, and sustain mission readiness longer.

In fact, much of this rethinking is coming from the US DoD as stated in its 5000.1 directive, which cites performance-based logistics (PBL) as its preferred approach to product support and improving an asset's mission readiness.

### **Pay for Performance**

Although traditional models for MROs were based on predetermined amounts of spare parts, repairs, tools, and asset history information, PBL is based on predetermined percentages of an asset's mission readiness.

To this end, the future revenue model for OEM/MROs is based on contractual agreements with weapons systems operators who reward or penalize them on the basis of the percent of a weapons system's availability. As a result, OEM/MROs must focus on improving spare parts forecasting, supply chain/service level planning and inventory management.

### **Spare parts forecasting**

Predictability is everything. The ability to predict inventory stock levels and maintenance schedules is what enables today's MROs to differentiate or die. In fact, it is the very measure of predictability that serves as the foundation upon which successful PBL models are built, managed and sustained. But while forecasting methods can increase the predictability of repair requirements, a forecast is only as reliable as the data feeding into it.

That's why MROs seeking to differentiate themselves from competitors must ensure the forecasts they produce are based upon a tightly integrated systems infrastructure with immediately accessible asset usage cycles, operational conditions and repair history information.

## Supply chain planning

Supply chain planning within the MRO operation is unique and differs from production planning in that it focuses not on the manufacture of an asset, but on the acquisition and logistics support of it. The essential elements of the MRO supply chain planning process requires maintenance technicians and engineers to:

- Identify maintenance tasks to be performed
- Determine the timing and frequency of each task.
- Design and document the procedural steps describing how each maintenance task will be performed.
- Describe and document the resources required to perform each maintenance task.

What truly differentiates manufacturing supply chain planning from maintenance planning, lies within the level of its predictability. While supply chain planning for manufacturing is relatively straightforward and predictable—based on forecasts from sales histories, pre-defined inventory requirements, supply chain capacity and customer demand. In contrast, the inherent complexity associated with maintenance planning programs is underscored by the erratic nature of asset usage conditions and intensive repair cycles associated with sophisticated weapons systems. This profound level of uncertainty can act like a lead ball chained to the ankles of MRO service providers, hampering their ability to accurately maintain inventory levels, estimate repair cycle times or guarantee mission readiness.

Fortunately, advances in technology have led to the emergence of robust, maintenance-specific applications that can be integrated across extended A&D supply networks, enabling MROs to increase the rate at which maintenance functions are predictable and as such, support the ability to quickly, accurately and cost-effectively:

- Determine equipment status and repair requirements
- Correct malfunctions before functional failures
- Replenish JIT inventories
- Return assets to mission-ready conditions

## Inventory management

When it comes to costs containment and return on investment, one of the most significant savings an MRO can expect is from tighter inventory control. The ability to effectively manage change orders, rotatable parts

inventory, unplanned material requirements and customer service level targets is what every MRO strives for. But many MROs still struggle to achieve these objectives. In fact, in order to optimize inventory, an MRO must:

- Understand where to hold specific quantities of inventory, lead times to replenishment, and cost of replenishment at the required location
- Set up warehouses in target locations and replenish inventory based on regional demand

Results of successful PBL s are impressive. In Afghanistan for example, the impact of PBL contracts for the F/A-18E/F availability has been about 85 percent, nearly a 20 percent improvement over the F/A-18C/D. Similarly, the PBL program for the Stryker has maintained roughly 98 percent operational readiness and 95 percent full mission capability with 310 vehicles in Iraq.<sup>3</sup>

In contrast, MROs that have not adopted PBL programs have significantly lower readiness rates, as evidenced in some of the army's helicopters, which have realized only 20 percent of their mission availability targets.

From these examples, one thing is certain—MROs that implement PBL methods to manage service operations can ensure success by clearly articulating specific performance metrics, negotiating feasible performance-based contracts, adopting total life-cycle systems management and implementing commercial off-the-shelf systems that support industry best practice.

## Operations

The blitzkrieg strategy for successful MRO operations involves the access to and reliability of performance data, historical utilization information and the planned deployment of future missions.

But while the means through which a successful blitzkrieg strategy can be executed is rigorous, MROs can flourish with this strategy through

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<sup>3</sup> [AIA Update: February 2005, Volume 9, No. 5](#)

failure mode, effects, and criticality analysis (FMECA). Specifically, FMECA provides MROs with the valid engineering intelligence required for managing maintenance task requirements, identifying catastrophic and critical failure possibilities and determining how these possibilities can be eliminated or minimized through design correction or repair.

Although FMECA is an essential method used to improve reliability, it also provides information for other purposes such as maintainability, safety analysis, survivability and vulnerability, failure detection and isolation subsystem design, and maintenance planning analysis activity. Specifically, FMECA enables MROs to:

- Identify all potential item and interface failure modes and defines their effect on the immediate function or item, on the system, and on the mission to be performed
- Evaluate each failure mode in terms of an asset's operational environment (e.g. the conditions in which the asset has or will be used), and the worst potential consequences, which may result and assigns a severity classification category
- Develop failure detection methods and make adjustments for each failure
- Measure effects of corrective actions or requirements for logistic support.
- Document the analysis and summarize the problems that could not be corrected by repairs and identify the necessary activities to reduce the risk of failure

## **Collaborative aftermarket service**

An MRO's collaborative planning process is often a collection of multiple disconnected processes—none of which can independently provide a holistic and reliable source of information. For most MROs, limited collaboration with operators and customers leads to low forecast accuracy; limited visibility into repair information and results in holding too much 'just in case' inventories, misdiagnosing asset repairs, and incorrectly estimating the long-term viability of deployment missions.

However, as the future of MRO effectiveness depends on its predictive maintenance capabilities, MROs require systems that proactively talk to each other throughout the entire operations lifecycle. Through service-

oriented architectures and industry-specific applications, this type of collaboration is not only feasible; it is also dependable and affordable. Moreover, through centralized databases and integrated applications, MROs can enjoy real-time access to parts histories, asset utilization and modifications, repair and service histories, service bulletins and air-worthiness instructions—all of which contribute to accelerating repair cycles, minimizing inventories, and increasing the length of time in which a weapons system is mission ready.

Collaborative aftermarket service also enables service providers and operators to collect performance data such as use conditions, routine maintenance and unscheduled repairs, throughout the entire parts lifecycle—and then compare any unscheduled activities against scheduled maintenance to determine the optimal threshold levels and improve predictions of scheduled maintenance requirements for the future.

## **Lean MRO**

Over the past several years, lean initiatives have become a key focus for many leading aerospace companies within manufacturing operations. The lean concept, established by Toyota Motor Corp to reduce costs by eliminating waste during the vehicle manufacturing process, has been successfully applied within several of today's leading A&D manufacturing organizations. However, MROs can realize significant performance improvements by implementing lean practices across their maintenance operations.

Specifically, lean maintenance refers to the elimination of waste produced by manual procedures, overstocked and underused inventory, and misallocated labor, time, transportation and logistics. Thus, the value of lean MRO can be measured in terms of the cost reductions and performance improvements gained when service providers and operators are able to:

- Reduce the number of unscheduled maintenance events
- Minimize inventory stock levels
- Boost labor productivity

## **Navigating the Process Map**

While there will always be some level of uncertainty within MRO operations, reducing unscheduled maintenance events and the time it takes to respond to them can have a huge impact on an MROs

productivity and profits. Through systems integration and application automation, MROs can accelerate the process through which performance data is collected and mapped to specific assets and their operational environments. Moreover, MROs can compare the frequency of scheduled maintenance events against unscheduled maintenance ones, rationalize their maintenance patterns, and ultimately adjust engineering data for specific maintenance requirements and their associated usage conditions.

### **Synchronizing Supply and Demand**

In many MRO operations, up to 35% of their inventory is rendered obsolete. This is because most MROs are unable to detect slow moving parts, which results in rampant inventory overstocks.

Further undermining this situation is lack of supply chain planning integration. In fact, when engineering, part usage history, maintenance history and operational environment history does not integrate with supply chain planning, it is not clear what inventory is required on hand and where it should be located and what should be procured just in time.

To avoid inventory overstocks and their ensuing obsolescence, MROs can now leverage robust supply chain applications that accurately forecast slow moving parts and provide visibility into each maintenance event. This visibility helps eliminate waiting because it increases the ability to repurpose repaired parts or systems on new, repaired or rebuilt assets.

### **Automating Opportunity-Based Maintenance**

Labor productivity and asset availability are undermined when maintenance opportunities are not effectively exploited—such as during downtime situations where mechanics and assets sit waiting until the next scheduled maintenance event occurs. For example, between missions, F16 Fighter Jets are often parked in aircraft hangars—where they sit, idle until their next scheduled maintenance event takes place or they resume operation.

To eliminate the waste that accumulates when labor and assets sit idle, MROs can implement automated unit scheduling systems that, when integrated with flight schedules, can suggest all the maintenance tasks associated with a particular weapons system that could be completed within the time the asset was parked and its next scheduled mission. Not only does this improve labor utilization and asset availability, it also reduces costs associated with carrying on-hand rotatable inventories and unscheduled maintenance incidences.



## ***Conclusions and Recommendations***

### Information-Driven MRO Supply Network

The future of the lean MRO enterprise is dependent upon having immediate access to accurate and timely information, analyzing that information for deep understanding, and applying that understanding to business processes that improve performance and eliminate waste.

By implementing best practices such as performance-based logistics, failure mode, effects, and criticality analysis, collaborative aftermarket service, and opportunity-based maintenance, lean MROs can optimize labor and asset productivity, increase mission readiness and ultimately compete for best value—globally.



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