Demand Driven MRP - MRP Comes to Fruition

White Paper Overview

The latter portion of the 20th century has been characterized by a transformational shift in manufacturing philosophy. A shift that has led to dramatic improvements in the overall efficiency of business processes. This transformation has been fueled by a litany of manufacturing methodologies that have driven process improvement through a variety of approaches and by introducing an array of innovative management tools. Three of the most prominent of these methodologies are **Lean**, **Theory of Constraints**, and **Six Sigma** – each linked by the common mission of improving manufacturing system flow by focusing on critical system objectives such as reducing process waste and variability; identifying and managing system constraints; or eliminating production defects.

Additionally, the integration of computer systems and spreadsheet based tools with manufacturing operations has similarly produced system improvement and increased efficiencies. One of the most significant technological innovations has been **Material Requirement Planning (MRP)**, a computer-based tool for material purchasing and production that has dramatically revamped and reformed the crucial function of supply chain management. Today, most manufacturing companies are using either traditional MRP or have adapted leading flow improvement methodologies, in particular Lean tactics and tools, to manage their manufacturing supply chains. Yet these companies have not completely realized the revolutionary advantages that were initially imagined or promised.

In this paper we will:

1. Provide a brief historical summary of the manufacturing revolution highlighting the key philosophies that have spurred it forward.
2. Examine the benefits and limitations of traditional MRP and why these systems are inherently incompatible with core Lean principles
3. Explain why, within the context of today's demanding business environment, traditional MRPs have become increasingly less effective.
4. Present a viable solution – Demand Driven MRP, the revolutionary methodology that resolves the inherent conflict between Lean and MRP
5. Highlight the specific DDMRP tools that need to be integrated with MRP to deliver a DDMRP solution and identify a commercial DDMRP product that features these essential DDMRP components

Going Lean

Lean manufacturing essentially means "manufacturing without waste." It has been estimated that most companies generally waste 70%-90% of their available resources through general manufacturing and business practices while the most proficient Lean manufacturers are able to reduce this to less than 30%. (Womack & Jones, Lean Thinking: Banish Waste and Create Wealth in Your Corporation, Simon & Schuster, 1996)

The techniques most commonly associated with Lean manufacturing are generally those that the Japanese developed and implemented to aid their industries in the years post-World War II. While the Japanese businesses, in particular Toyota, did have a significant role in advancing Lean techniques and proving the efficacy of the Lean model, Lean manufacturing did not begin with Toyota. Nor is Lean confined solely to the specific approaches which the Japanese championed. In actuality this philosophy has a much more extensive history that includes the contributions of many business innovators who have advanced the cause of Lean.

Abbreviated History of Lean Manufacturing

Innovator	**Contribution**	**Time Period**
Eli Whitney	Perfected the process of individual parts manufacturing	1799
Frederick W. Taylor	Credited with originating **Scientific Management** by applying science to management as he studied individual workers and workers to develop concept of **Time Study** and standardized work.	1890's
Frank Gilbreth	Developed **Motion Study** and invented **Process Charting** which focused attention on all work elements including those non-value added elements which normally occur between the "official" elements.	1890's
Henry Ford	Fashioned the first comprehensive **Manufacturing Strategy** by taking all the elements of a manufacturing system-- people, machines, tooling, and products-- and arranged them in a continuous system for manufacturing the Model T automobile.	1910's
Taichii Ohno,/ Shigeo Shingo	**Just In Time Production** - how material should be processed and moved in order to arrive "Just In Time" for the next operation. Formed basis of **Toyota Production System (TPS)**	1949 - 1975
Norman Bodek	Published the works of Shingo and Ohno in English thereby building awareness of **TPS** principles to the Western world.	1980's
John Krafcik	His business novel "The Machine That Changed the World" was a comparative study of Japanese, American, and European automotive auto manufacturing, plants, originated the phrase-- "**Lean Manufacturing**." and inspired manufacturers around the world to adopt lean manufacturing techniques	1990
Bob Galvin/Motorola	Developed new quality standard of measuring defects per million opportunities and created the methodology and needed cultural change to implement this **Six Sigma** quality system within organization. Motorola soon documented more than $16 Billion in savings as a result and Six Sigma was quickly emulated by other industry leaders including Larry Bossidy (Allied Signal/Honeywell)and Jack Welch (General Electric Company)	1980s – 1990's
Dr. Eliyahu M. Goldratt	Introduced the **Theory of Constraints (TOC)** in his business novel "The Goal" The set of management tools he introduced allowed for the identification and effective management of system constraints and became critical components of many lean manufacturing approaches.	1984

3 Lean Related Philosophies

Three critical business philosophies have emerged to form the nexus of prevailing Lean manufacturing thought. Each of these approaches focus on improving business flow as the impetus to improving business efficiency and the productivity of functions company-wide.

- **Lean** – reduce waste
- **Theory of Constraints** – Improve Throughput
- **Six Sigma** – Reduce Variability

Lean

The lean revolution was triggered, by of all things, a routine trip to a supermarket. In 1956, two Japanese engineers, Taiichi Ohno and Shigeo Shingo visited America at the prompting of their boss, Kiichiro Toyoda, the head of Toyota. The primary purpose of their trip was to visit US automobile plants to come up with ideas that Toyoda may implement in his production facilities. However, post-war Japan was beset with challenges and conditions that were not relevant to the American businesses of the 1950's who were enjoying the benefits of pursuing an aggressive mass manufacturing strategy. These challenges included limited geographic space, limited capital investment, and limited supply of raw materials. Clearly a different blueprint would be needed in Japan.

Ohno found the inspiration for this different approach by observing how supermarket shelves were replenished only when customers removed produce. This ensured that the supermarket only had to purchase what the customers were buying and could minimize their stocks as a result. A system similar to this would be vital in a Japanese economy that was so short of resources.

This triggered the development of the **Just in Time** and **Kanban**, methodologies which would revitalize Toyota and come to form the foundation of the **Toyota Production System (TPS)**, and by extension, Lean philosophy. Implementing TPS not only resulted in increased productivity for the company's manufacturing facilities, but soon enabled Toyota to generate increased revenue and market share in every global market, eventually leading to the company becoming the largest automaker in the world.

- **Just in Time (JIT)** – JIT is a production/inventory strategy companies employ to increase efficiency and decrease waste by receiving goods only as they are needed in the production process, thereby reducing inventory costs… To accomplish this, items are created to meet demand, not created in surplus or in advance of need. This approach requires that manufacturers are able to accurately forecast demand.
- **Kanban**- Kanban is a Japanese word meaning signal. Kanban is essentially not an inventory control system but rather a scheduling system that determines when to produce and how much to produce. In the Kanban system a Kanban card or other device such as an empty bin is used to signal to the operation that it needs to produce.

In a Kanban system the levels of inventory are set based upon forecasted demand. For the system to work effectively any variation to demand must be anticipated. In situations where demand is not stable, the Kanban system will require constant monitoring and updating to adjust to changes in demand. Similarly, Kanban systems work best when the number of product configurations is limited. Increases in product differentiation requires a Kanban system for each different part used in product production, thus increasing inventory levels.

Kanban is an example of a **pull system**. In a pull system the operation pulls products only as needed, as in when the next station signals that it needs parts.

Theory of Constraints

Theory of Constraints (TOC) is a lean approach that systematically focus efforts, energy and attention on the "system constraint." This constraint, or bottleneck, restricts the output of the entire system and at the same time represents the primary leverage point for improving it. Simply put, TOC means identifying constraints and managing them.

To accomplish this, TOC shifts the focus of management from optimizing separate assets, functions and resources to increasing the flow of throughput generated by the entire system. TOC's key processes are focused on removing barriers that prevent each part from working together as an integrated whole.

Six Sigma

Six Sigma is a disciplined, data-driven approach and methodology that achieves process improvement by eliminating defects. Whereas most lean manufacturing approaches are geared to improve the process, in theory, Six Sigma is designed to perfect it. The quality of process outputs is improved by identifying and removing the causes of defects (errors) which then minimizes the variability within manufacturing and business processes.

Some of the elements discovered during the Six Sigma investigation are classified as elements which constrain the flow of products or services through the system. Flow is defined as the time from the input of raw material to the output of a salable item. Improvement of a process that was restricting flow results in reduced variation, better quality and improvement in the volume of the process output. Thus the organization has less money tied up in in-process inventory. The time from paying for input material to seeing a profit is reduced, and the organization can respond to customer needs more quickly

Comparison of methodologies.

Each improvement methodology contributes valuable improvement concepts, ideas and techniques to an organization and many organizations will adhere to some combination of philosophies and approaches.

Philosophy	Theme
Lean	Focusing on waste removal will result in improved flow time
TOC	Focusing on constraints, will improve throughput volume
Six Sigma	Focusing on reducing variation will result in more uniform process output

The Role of MRP

A typical manufacturer's supply chain is an interconnected network of individual "islands" and "archipelagos" of manufacturing processes. At the heart of these islands is **Material Requirements Planning (MRP)** connecting the demand signals in these supply chain "islands" and "archipelagos" as it coordinates the planning of critical manufacturing, purchasing and delivering activities.

MRP originated in the 1960s in the USA as a computer-based tool for material purchasing and production. MRP can be considered as a flow control system. It generates reports to procure or produce components that are required to maintain the flow of the product.

The starting point for an MRP system is the **bill of materials (BOM)**. A BOM describes the "parent-child" relationship between a finished part and its components. The MRP system is based on the premise that one can derive the demand for individual components based on the demand for the parent item. An MRP system is driven by a **Master Production Schedule (MPS).** The MPS contains the demand (with dates) for each level product. In addition to the information contained in an MPS and BOM, an MRP system uses information on the current inventory status and product lead-times.

Manufacturing lead time is the total time required to manufacture a product and includes the set-up time, processing time, queue time, inspection time and transport time. Similarly, the purchasing lead time is the total time required to obtain a purchased product and includes the procurement time. An MRP system produces a time phased schedule called a materials requirement plan.

MRP Push vs. Lean Pull

A widely accepted definition of Lean manufacturing is the "*systematic approach to identify and eliminate waste (non-value adding activities) through continuous improvement by flowing the product at the pull of the customer in the pursuit of perfection*" (Brue & Howes, 2006). In doing so. Lean focuses on reducing the business cycle time so as to become more responsive to customer demand, while using less resources and improving products and processes. This results in lower costs, increased productivity higher profits, flexible production capability and overall increased operational efficiency.

The **Pull inventory Model** simply relies upon the ability to order or make products as they are requested by customers. In doing so it adheres to Lean JIT principles and relies on the placement of smaller and more frequent material orders. The key intended advantage of a Pull System is manufacturers don't spend money ordering or storing finished products until after customers have made purchases. In this way, customer demand is efficiently met without incurring excess inventory and the business may effectively react and adapt to consumer buying trends as they unfold. However, since customers are unwilling to wait for the full combined procurement and manufacturing Lead Time that is required; it is necessary to maintain inventory levels of numerous items. These inventory levels are generally set based on a forecasted demand. Then, because Lean often sees computer-based processes as contributors to system waste, manual systems are often implemented. These manual systems can become very cumbersome and are unable to quickly react to unexpected variation in customer demand, particularly with a large product mix. Additionally, the upstream item does not receive the replenishment signal until its predecessor has been consumed or shipped and the Kanban card has been pulled - resulting generally in the loss of precious lead time due to the lack of proper visibility.

Conversely, MRP attempts to help organizations maintain proper inventory levels by utilizing a **push inventory model** in which production levels are once again based upon sales forecasts. Central to the push approach is the forecasting of customer demand to establish Production Planning. Since customers are still unwilling to wait the total necessary Lead Time, companies must predict which products customers will purchase and at which quantity. Under-estimating demand will result in too little inventory and lost sales. Over-estimating demand means excess inventory resulting in price markdowns and potential product loss. Since the computer system is able to recalculate things so quickly based on this perceived demand, the intrinsic error in forecasting can cause numerous scheduling interruptions and chaos. Many manufacturers will 'Build' inventory based on a given forecast and then 'push' the product and hope it sells. Implementing a push system requires a company to rely heavily upon long-term projections to meet consumer demand without oversupplying or undersupplying. After forecasting what the demand will be for a given period, a company will order accordingly and push the products to consumers. A key benefit of a push system is reduced shipping costs - push systems revolves around placing larger, less-frequent orders, which cuts down on the number of shipments.

Companies in stable and highly predictable industries tend to do well with this strategy more so than companies in industries with less stable demand.
Therefore, the success of the **push inventory model** depends on excellent forecasting as products are manufactured to meet anticipated demand. The belief and hope is that prior sales will accurately predict future demand. Even the best inventory systems with the most sophisticated forecasting calculations will nearly always miscalculate demand. This will lead to high carrying costs, forced markdowns and write-offs, or the inability to meet customer demand and lost sales. In fact, the most significant challenge for the push inventory method is the unpredictability of customer demand.
MRP systems are designed to work in a perfect JIT world where Inventory formula's net to zero, customers know exactly what they want and suppliers always deliver on time.
Push – Pull Comparison

Push	Pull
Made to stock	Made to order
Inventory level based on forecasted demand	Inventory level based on historical and planned customer orders
Does not limit WIP within system	Establishes limit to WIP within system
Work scheduled based upon forecast	Work released based upon Customer shipments
Control release date, observe WIP level	Control WIP level, observe throughput
Places larger, less frequent orders	Places smaller, more frequent orders
Best suited for environments characterized by stable demand	Reactive and adaptive to changes in consumer demand mix, but unable to react to significant change

The "New Normal"
Today, almost every mid-size to large company is using MRP tactics and tools to some degree. It is clearly difficult to effectively manage a modern supply chain system without robust MRP. However, the world is a much different place than it was over 50 years ago when MRP was initially conceived and codified. Lead times have all but disappeared and Product Mix and complexity has literally exploded.
As Chad Smith, a Supply Chain expert and co-founder of the Demand Driven Institute succinctly stated - *"We have more complex planning and supply scenarios than ever and conventional planning can no longer handle it. We have reached the point of diminishing returns. Companies that keeping applying and optimizing old rules and tools, will put more in and get less back" ("*New Rules for the 21st Century Supply Chain", Demand Driven Institute, 4/11*)*
With the passage of time, a changing environment has created a "new normal" of external and internal factors that have further compromised the effectiveness of both MRP and Lean. These new environmental factors include:

- Global sourcing and demand
- Shorter product life cycles
- Shorter customer tolerance times
- More product complexity and/or customization
- Pressure for leaner inventories
- More product variety
- Long lead time parts/components

All of these factors have clearly increased the complexity and intricacy of inventory planning activity. Global markets, greater product variety, and enhanced product customization have created a need for longer and larger inventories at a time when businesses are increasingly facing financial pressures to become leaner. Similarly, global sourcing and increased product complexity have lengthened manufacturing cycle times in an environment where customers are more demanding and less tolerant regarding delays in product fulfillment.

Most significantly, the new normal environment has made it increasingly difficult to generate accurate forecasts – the most critical component for the push and promote driven traditional MRP. And the exponential growth of product variety makes it increasingly difficult to manage with cumbersome manual Lean approaches. Faulty forecasting results in not just inadequate inventory levels but in businesses committing capacity, materials, space, time to the wrong products. Likely negative consequences include lost sales, higher inventory costs and diminished profitability. Clearly any of these results are the antitheses of an effective lean organization.

The New Normal

Circumstance	1960's	Today
Supply Chain Complexity	Low. Supply chains looked like chains – they were more linear. Vertically integrated and domestic supply chains dominated the landscape	High. Supply chains look more like "supply webs" and are fragmented and extended across the globe.
Product Life Cycles	Long. Often measured in years and or decades (e.g. rotary phones)	Short. Often measured in months (particularly in technology)
Customer Tolerance Times	Long. Often measured in weeks and months	Short. Often measured in days with many situations dictating less than 24 hour turns
Product Complexity	Low.	High. Most products now have relatively complex mechanical and electrical systems and micro-systems. Can you even work on a modern car anymore?
Product Customization	Low. Few options or custom feature available.	High. Lots of configuration and customization to a particular customer or customer type.
Product Variety	Low. Example – toothpaste. In 1965 Colgate and Crest each made one type of toothpaste.	High – in 2012 Colgate made 17 types of toothpaste and Crest made 42!

Long Lead Time Parts	Few Most parts were domestically sourced and thus often much “closer” in time.	Many. Today’s extended and fragmented supply chains have resulted in not only more purchased items but more purchased items coming from more remote locations.
Forecast Accuracy	High. With less variety, longer life cycles and high customer tolerance times forecast accuracy was almost a non-issue. “If you build it, they will buy it.”	Low. The combined complexity of the above items is making the idea of improving forecast accuracy a losing battle.
Pressure for Leaner Inventories	Low. With less variety and longer cycles the penalties of building inventory positions was minimized.	High. At the same time operations is asked to support a much more complex demand and supply scenario (as defined above) they are required to do so with less working capital!
Transactional Friction	High. Finding suppliers and customers took exhaustive and expensive efforts. Choices were limited. People’s first experience with a manufacturer was often through a sales person sitting in front of them.	Low. Information is readily available at the click of the mouse. Choices are almost overwhelming. People’s first experience with a manufacturer is often through a screen sitting in front of them.

Source: Demand Driven Performance – Using Smart Metrics (Debra Smith and Chad Smith, McGraw-Hill, 2013)

Solution – Moving from Push and Promote to POSITION AND PULL

Globally supply chains are becoming more complex and companies struggle with this increased complexity. A recent study by the Aberdeen Group shows –

“48% of companies indicate that increased supply chain complexity is a top pressure”

Today almost every mid-size and large manufacturing company is using MRP tactics and tools to deal with this complexity. Many of these companies recognize the inherent benefits to going lean but also recognize that a simple pull approach is an oversimplification of the truly complex supply chain management scenario that is part of the new norm. The lean approach, characterized by reliance on rudimentary Kanban controls and by lack of formal material planning, tends to not provide sufficient visibility to critical dependencies and relationships that exist within a complex supply chain. Within this complex environment, it is essential to have the visibility MRP offers - visibility that enables supply chain managers to fully see their system’s total requirements picture and thus avoid critical system blind spots that could lead to inventory shortages or excesses. Unfortunately, businesses and managers have commonly been forced to sacrifice the efficiency of pull to achieve these benefits of MRP.

Is there a way to reconcile this core dilemma? A way to achieve the positive impact to system flow of Lean while still harnessing the practical sophistication of MRP?

One emerging solution is **Demand Driven MRP (DDMRP)**, a breakthrough supply chain management methodology that bridges the worlds of Lean and traditional inventory planning.

By implementing **DDMRP,** businesses may effectively migrate their MRP from traditional “Push and Promote” to “Position and Pull”.

DDMRP provides this solution by focusing on the first law of manufacturing –

All benefits will be directly related to the flow of materials and information.

This is a principle that both MRP advocates and Lean adherents readily accept. By creating a high degree of flow to their customers, companies will achieve improved quality, reduced costs, increased profitability and a decisive competitive edge within the marketplace. (“The State of DDMRP”, Demand Driven Institute, 2/12)

DDMRP ties improved flow to two critical system requirements:

1. **Pace to Actual Demand**
The company system and resources must be aligned as closely as possible to actual demand. This means fulfilling and replenishing critical positions along supply chain as close as possible to actual consumption without incurring frequent service disruptions. This requires adhering to an approach that focuses on increasing the responsiveness of system resources to signals generated by traditional Lean tools.
2. **Visibility to Bigger Picture**
There must also be visibility to the total requirements and system status across the enterprise. This is particularly true within business environments characterized by extended supply chains, long lead times and complex BOM's. Generally, MRP systems provide this depth of visibility by taking demand signals, exploding the BOM against each item on hand, performing necessary calculations and recommending the issuing of supply orders.

By adhering to these principles in its planning and execution functionality, DDMRP is effectively able to position inventory to respond to true demand signals which enable flow to be organically pulled through the supply chain. More specifically. **Position** is achieved by utilizing system visibility via the exploded BOM to make correct strategic decisions as to where to hold inventory and at what levels while Pull is accomplished when production is driven by demand, not forecasts.

DDMRP utilizes a proven multi-echelon methodology that integrates multiple tiers (including BOM's) in the supply chain to provide end to end integrated planning as well as execution visibility. It is the perfect approach for the "new normal" as it both mitigates the effects of variability and volatility by decoupling manufacturing and related supply chains AND promotes visibility and velocity.

DDMRP also enables managers to answer the most critical questions regarding the supply chain – Where along the supply chain should stock be held? Holding stock is not wasteful, but holding stock everywhere and holding stock nowhere is wasteful. The key and first component of DDMRP is to find out where the right places to hold stock are. ("The State of DDMRP", Demand Driven Institute, 2/12)

To effectively answer this critical inventory question a business must identify the strategic items or decoupling points within its supply chain - locations where inventory is placed to create independence between processes. Decoupling points identify which stock (SKU/parts) are truly strategic and, when stocked, minimize lead times, system variability and increased ROI. Therefore DDMRP represents a perfect balance between the Lean mandate to make all system processes independent and the traditional MRP approach of complete system dependency. Making everything dependent in today's volatile and variable environment is no longer a practical option; making everything independent complicates inventory management and will generally result in too much stock. "DDMRP is a blend of dependence between independent points." ("The State of DDMRP", Demand Driven Institute, 2/12)

Finding a Commercial DDMRP Solution

In essence, DDMRP is an unprecedented fusion of critical MRP tools with the pull- based approaches and signals of Lean and TOC and the reduction in variability focus of Six Sigma. The key to its effectiveness is retaining Lean's waste reduction focus with the correct set of demand driven planning tactics - the ones that will provide the optimum degree of planning visibility across both enterprise and supply chain. ("Lean Finds a Friend in Demand Driven MRP", Demand Driven Institute, 4/11)

The DDMRP Institute have identified the following DDRMP tools as being critical components of an effective DDMRP:

DDMRP Critical Components	Description
5 Zone Buffers	Provides easy status and relative priority visibility for planning and execution
Dynamically Adjusted Buffers	'Flexes" buffer position based on changes to consumption
Planned Adjustments to Buffers	Accounts for seasonality, product introduction/deletion/transition
Globally Managed Buffer Profiles	Parts/SKU are grouped by like attributes for ease of management
Decoupled BOM Explosion	Creates a unique blend of dependence and independence for planning
ASR Lead Time Calculation	Lead time generation based upon the BOP's longest unprotected sequence
Order Spike Protection	Highlights and accounts for problematic sales orders based on a threshold and horizon
Material Synchronization Alert	Identifies specific misalignments between child supply and parent demand
Multi-Location Buffer Status Visibility	Relative status visibility across a distribution net for like parts/SKU
Lead Time Managed Pads	Managing critical non-stocked items through timed alert zone

Matrix BOM + ASR Lead Time Analytics	A revolutionary lead time and working capital compression approach across all BOMs

Source: "The State of DDMRP", Demand Driven Institute, 2/12

The seemingly deterministic nature of MRP has long made it a target for software solutions. But until recently software approaches to MRP have not been up to the practical challenge of handling the real world complexity of fast delivery times, product variation and supply chain disruptions. Demand Driven MRP now offers resupply algorithms sophisticated enough to include such factors. Complex part, BOM, order, and projection data is required to drive these algorithms. While there may be Demand Driven bolt on applications or modules for ERP systems, they generally require difficult integrations to access and compile all the necessary information to be analyzed. Backbone from Custom Intelligence is a fully integrated DDMRP solution in which the DDMRP tools are part of the core functionality of the software. Backbone drives the full range of factory operations, so it naturally collects all the necessary data for driving the algorithms. Backbone is engineered to even support implementation of all manufacturing optimization methodologies. It has the industrial strength and flexibility needed to model hundreds of thousands of complex parts and their optimization factors to any desired level of detail. It manages production and material flow and collects the real time feedback necessary to make daily optimization decisions.

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