

# Generate Value Throughout the Entire Supply Chain Enterprise

Leveraging IT for Lean, Agile and Six Sigma  
Business Value Research Series

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## Introduction

Since the introduction of an industrial-based economy, all sectors of industry have strived to improve productivity. The Industrial Revolution was, as its name suggests, a true revolution, replacing the craftsmen with sophisticated tools and machinery. Companies in all market sectors have been intent on improving their performances year after year in the same way that athletes manage to establish new world records at every major sporting event. The mission for “lean and mean” continues and since the 1950s has followed the Japanese model embracing such methodologies as Total Quality Management (TQM), Kaizen, Just-in-Time (JIT) Inventory, Value Stream Mapping and Six Sigma—just to name a few. However, the “lean machine” in any factory may not necessarily satisfy the customer’s desires for the value for money, quality of products and services, responsiveness of the suppliers and support from cradle to the grave. So, what is being demanded of world-class companies in the 21st Century is the delicate balance of being efficient (lean), responding rapidly to changing customer needs and market forces (agile) and producing quality products from quality processes (Six Sigma).

The adoption of lean, agile and Six Sigma concepts is generally focused on the shop floor, but this is only the tip of the value iceberg (refer to Figure 1). To uncover the hidden, but massive, value potential, it is imperative that these methodologies are extended beyond the manufacturing plant to include all critical processes within and between each stage of the supply chain network: exporter, importer, ports, freight forwarder, vendor, manufacturer, distributor, retailer and customer. The real value of a lean and agile transformation is outside the factory walls.

This paper focuses on how lean, agile and Six Sigma concepts can be effectively leveraged to create value throughout the extended supply chain. It is no longer sufficient to consider only lean, agile and Six Sigma in terms of just traditional manufacturing, a more revolutionary approach is now necessary as illustrated in the iceberg diagram manufacturing is only the tip of the iceberg.

Uncovering the hidden value throughout the global supply chain network requires applying the basic constructs of lean, agile and Six Sigma with integrated solutions in advanced planning, supply chain planning, warehousing, logistics, collaboration, and business intelligence.

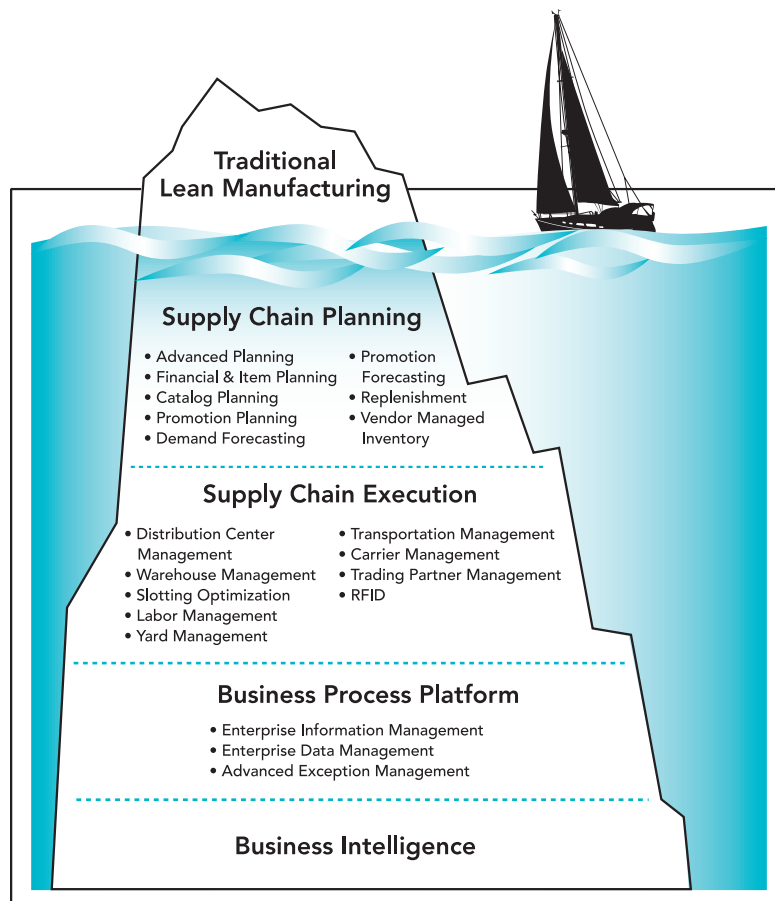


Figure 1: The “Iceberg Effect” leveraging lean and agile concepts beyond manufacturing

## Extending Lean, Agile and Six Sigma

An ARC Advisory Group strategy report, authored by Simon Bragg (2004), suggests that, today, 36 percent of U.S. manufacturers and 70 percent of U.K. manufacturers “are using lean as their primary improvement methodology.” But there is nothing dramatically new in lean manufacturing at the shop floor since its inception nearly 60 years ago from its roots in the Toyota Production System. It’s our estimation that no more than 10 percent of these companies have moved lean beyond the four walls of the plant.

Extending lean manufacturing principles to the supply chain is non-trivial. However, **the extension of lean concepts across a complex supply chain network of suppliers, customers and partners can result in dramatic financial improvements** for all. Significant benefits in reduced cycle times, increased production yields and quality levels, decreased inventories, minimized waste, lowered costs and increased customer satisfaction are to be expected, which in turn, drive increased revenue and improved operating margins.

Lean supply chain operations require continual optimization, monitoring and refinement, which cannot be accomplished without a solid Information Technology (IT) platform. As backbones and data repositories, traditional solutions such as enterprise and supply chain planning applications can be essential for enabling a holistic, lean manufacturing operation. However, many lean purists hold that traditional IT applications such as ERP, by definition are anti-lean, using push logic to populate the manufacturing operation with materials, rather than pulling actual customer demand driven inventories to create a continuous flow environment. Using standard costing and least total cost logic will often drive decisions that prove to be counterproductive if the impact of the total supply chain is not considered.

Moving to common IT platforms to free the organization of the paradigms of mass thinking will allow pursuit of new ones in lean thinking. As the need for agility increases in growing complex supply chains, supply chain management solutions can be used to make a difference between a successful lean roadmap and world-class supply chains from those that have failed from their inception.

In the 1980s, lean production was used by authors of the International Vehicle project at MIT to describe the approach originally developed in the Japanese auto manufacturing industry. This approach—often called Just-In-Time (JIT)—contrasted with the mass production approach common in the United States and Europe at the time.

Lean production is “lean” because it uses less of everything compared to mass production—half of the human effort in the factory, half the manufacturing space, half the investment in tools and half the engineering hours to develop a new product in half the time. It also requires keeping far less than half the needed inventory on site, which results in many fewer defects and produces a greater and constantly growing variety of products.

Subsequently, one can expand this definition of lean to strongly emphasize reducing the use of all resources, not only in the factory but also in activities extending beyond the shop floor.

“Simply put, lean is the practice of continuous improvement based on the removal of waste, by reducing the cycle or flow time. It has as its guiding principle the identification of value through the value stream mapping process, and it strives to create a flow through the manufacturing process with the goal of reducing cycle times.

The objective is to meet market demand with a pull replenishment model. The ultimate goal is to deliver products to customers that are perfect in quality, meet the expected delivery date, and are priced as low as possible.”

Judy Sweeney, AMR Research,

“*Lean Manufacturing, Part I: Introduction*,” January 4, 2006

## Extending Lean to International Suppliers and Customers

From being sole owners of all components of the supply chain—manufacturing, distribution, transportation and customer service—companies have evolved business processes and solutions to become interactive global trading partners in a near real-time environment.

The opportunities in China, for example, demonstrate the dynamics of today's global supply chain. China's overall impact on the global economy cannot be taken lightly. China is not only one of the most attractive places to offshore manufacturing, it is fast becoming the largest consumer goods market in the world.

Fuel costs are at all-time highs, affecting transportation costs. The impact of global sourcing amplifies these costs and must ultimately be absorbed by someone in the supply chain—including, in many cases, the end consumer. As a result, driving lean efficiencies on a global basis is more important than ever.

Profitably building a lean supply chain network requires that manufacturing operations synchronize with customer demand and produce acceptable quality products as needed. A manufacturing strategy that is based on reduced variability, production to demand, waste elimination and optimal cycle time will drive over all supply chain success. Manufacturers that cannot control variability will not be able to move toward lean demand driven replenishment strategies cost effectively.

### Where the Real Value Is Found

Lean supply chain projects take time and as **companies grow their businesses, challenges must be overcome. However, many components of an extended lean enterprise** can add significant value in relatively short periods of time. To do so, companies need tightly-integrated and highly-functional solutions that can manage and execute long-running, event-driven business processes across the enterprise. Using supply chain management solutions enables functional business process capabilities and service oriented architecture to provide the business processing platform to deliver that functionality.

Combined, supply chain management solutions and a business process platform create a platform for logistics. This platform for logistics will open new doors of opportunity for companies to drive additional revenue while decreasing supply chain costs. These areas range from the very short term to the strategic:

#### Tactical Benefits

Implementation of supply chain management solutions allows for efficiencies to be gained across discrete supply chain processes, such as warehousing, supplier and manufacturing plants and logistics and transportation operations. Benefits include increasing overall labor productivity and order accuracy while decreasing inventory and labor costs throughout the supply chain.

#### Innovative Opportunities

In addition, supply chain management solutions allow companies to think outside the box and realize new opportunities that may not have been previously achievable. Initiatives may include direct store delivery programs, shared services, multi-channel distribution or migrating from a pre-paid to a collect model for transportation to drive down transportation costs.

#### Evolutionary Initiatives

Supply chain management solutions enable companies to take their businesses to new levels. In today's environment of better, faster and cheaper, companies must look for ways to streamline business processes and focus on core competencies to drive customer value. This may mean outsourcing initiatives or offshoring manufacturing.

## Extending Lean Concepts through the Supply Chain: ROI

The real return on investment (ROI), when extending lean concepts through the supply chain, comes from the improved execution activities of the entire business, not just the manufacturing operations functions. Research studies have estimated that the benefits of extending the lean methodologies and techniques throughout an interdependent supply chain network could be multiplicative, relative to the benefits derived from a single enterprise deploying the same tools solely at the shop floor level. ROI areas of focus beyond manufacturing include:

- Evaluate each supply chain process as to applicability of lean concepts, both enterprise and cross-enterprise. Transportation and procurement areas are generally good starting points.
- As lean concepts move from enterprise to extraprise, major suppliers, customers and partners must be included.
- New supply network strategies may need to be considered while deploying lean concepts.
- Mutually beneficial relationships must be built with partners to share information and synchronize planning activities driven by customer demand characterized by pull demand concepts.
- A correct supply network must be built, including the supply side component, to prevent stock out, excess stock buffers and replenishment on demand.
- Companies must strive for agile, same-day manufacturing execution capabilities with minimal variability in order to meet real customer demand.

Meeting the requirements of customer-driven demand with its implied uncertainty and variability through interdependent supply networks is not a small undertaking and will take time, especially for the cultural aspects of the required change in mindset. Companies must start now by building a cross-functional team to define their manufacturing and supply chain network strategy, and designing a roadmap for deployment of applications that incrementally build manufacturing and supply chain efficiency, quality and agility.

Real value creation is found via the extension of lean manufacturing concepts across the supply chain network.

# Extending Lean, Agile and Six Sigma: A Roadmap to Success

Traditionally, manufacturers have not built their entire supply chains to respond in a synchronized way to variability in customer demand. This means production is centered on making products to forecast and then push high levels of inventory into the supply chain to manage variability. Eventually, these companies need pricing discounts or promotional campaigns to create demand to move the excess or they will face substantial write-offs. These write-offs come at a more rapid time pace due to the faster introduction of new and competing products. Real-time demand information coupled with real-time inventory visibility and availability for production is the biggest hurdle to lean beyond the production system. Silos of efforts on areas such as asset utilization, production efficiencies and cost cutting have lead to only incremental unsustained benefits. Solutions are needed to manage and optimize the changes in customer demand to execute the transaction in the most effective way for the enterprise as a whole.

In today's increasingly fast-moving, highly-complex environments, enterprises must continually adapt by managing large amounts of data while executing complex workflows outside the

four walls and then communicate these adjustments to multiple locations. These agile supply chains require enabling software and a robust service orientated technology platform. Without IT, extended enterprises can't be truly lean or Six Sigma enabled.

Leading manufacturers will need interdependent supply networks which combine back-end business planning and operations in conjunction with lean methodology and practices across the supply chain. Traditional pull systems such as legacy and ERP fall short when applied to a networked supply chain model for the following reasons:

- Lack of visibility across the entire network;
- Rigid, slower and error-prone ERP systems;
- Legacy systems which are not scalable and unable to be supported by customers, suppliers and partners;
- ERP and legacy systems struggle with managing continuous demand variability or sudden spikes in demand.

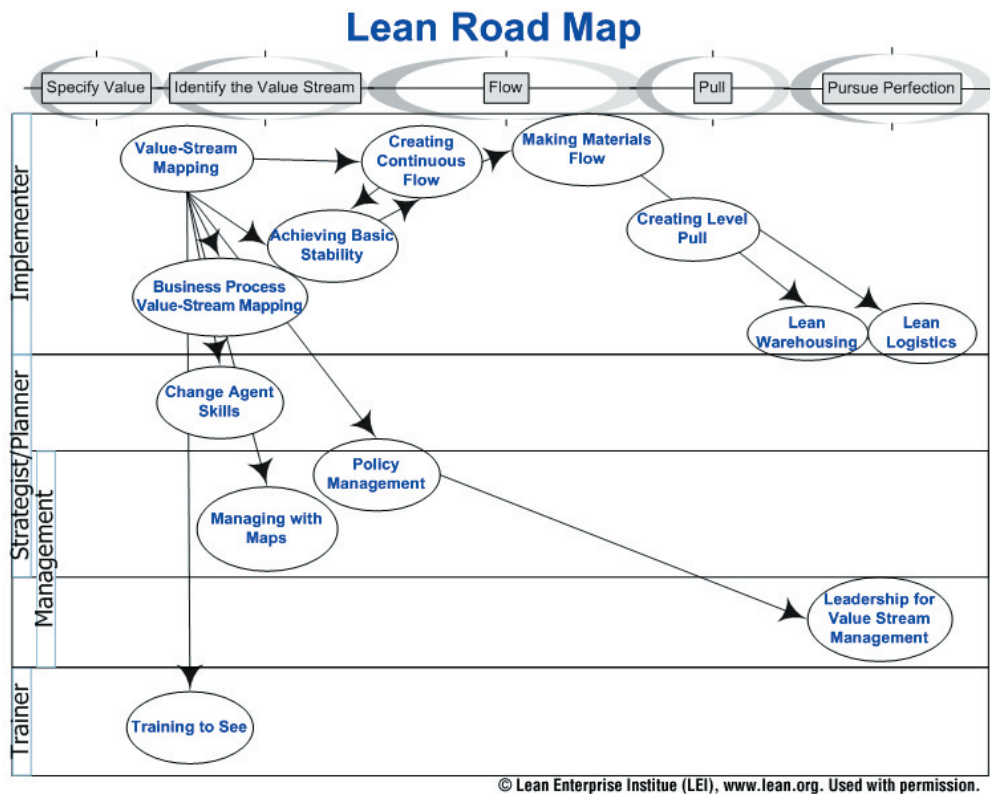


Figure 2: Lean road map

## Addressing Current Business Trends

### The Increasing Use of Logistics Service Providers

Another trend in supply chain management is outsourcing of key operations to the “experts.” More companies are relying on logistics service providers (LSPs) to meet business challenges. Experts can be defined as companies well-versed in a certain geographic area such as retail distribution, transportation or manufacturing. Some companies use LSPs to increase their presence in key and foreign markets. Others focus on their core strengths and outsource other areas such as distribution and transportation to LSPs. Still others are outsourcing IT in order to focus key resources in crucial areas within the business. Regardless of the reason, it is apparent that companies are relying on external resources to create the most efficient supply chain possible. As a result, more LSPs are seeking to expose certain business functions to their customers. In an effort to work more closely with trading partners, LSPs look to share vital information such as inventory levels and order status to provide customers with greater visibility into their assets and initiatives. Utilizing a service oriented architecture for supply chain management solutions makes this possible.

Looking at today’s supply chain leaders, it is evident that these companies have embraced an inter-enterprise model where they rely on trading partners to share mission-critical information to more effectively run their supply chains. With the popularity of offshore manufacturing and outsourcing of key logistics components, it has become imperative for companies to adopt an inter-enterprise mindset versus a more discrete model in which each node in the supply chain acts alone. Although difficult, the advances in technology make this change possible. Utilizing the Internet, companies can further establish and maintain partnerships with trading partners—suppliers, customers, carriers, etc.—creating efficiencies through greater visibility.

As companies deploy lean strategies in the production environment, the following points should be considered as an expansion of the scope of the project:

- In transitioning the production environment to support a customer-driven demand model, firms must also extend this strategy through the supply chain;
- Lean practices can be implemented throughout the supply chain simultaneously with the right plans and partners, further accelerating ROI;
- Improvements in supply chain communication and collaboration are a prerequisite to complete production efficiencies;
- Understanding the impact and integration requirements of lean with networked partners is a key variable to achieving real results.

Focusing on improving lean methodologies and practices through technology can result in enhanced supply chain network communication and collaboration among its participants. Lean enablers in the form of software applications, in conjunction with best practices, and continuous monitoring, optimizing and adjusting, will make lean stick.

As suppliers are brought into the effort, best practices extend further and benefits increase through the following:

- Purchasing savings grow through using best category contracts by buyer or supplier to increase leverage;
- Automation of procedures cuts transaction costs and elimination of errors cuts reconciliation times and costs.

As better knowledge is shared with customers, top line results occur such as:

- Visibility into the supply chain, which allows better matching of stocks with current demand-increasing sales;
- Special promotions, which become better as the right goods are available at the right place and time;
- Banished out-of-stocks.

## Technology Advancements

Although service oriented architecture has been discussed for years, we are beginning to see its fruition as applications are being built on this premise of creating shared business objects to leverage data between trading partners. Today's technologies allow the creation of a virtual company to share data and work together to service the same need versus working independently. Through the use of service oriented architecture, it is transparent to users and customers which business system or node within the supply chain is actually executing a transaction.

In addition to the Internet, other technological advancements have altered the way we do business today. With newer technologies such as RFID, sense and respond, mobile computing and service oriented and event-based architecture, accessibility to information is greatly enhanced. More accurate, timely information allows us to make proactive decisions to ultimately meet customer needs and drive efficiencies throughout the supply chain. These technologies permeate all supply chain activities and provide value across nodes—distribution centers, logistics hubs and manufacturers. These facts should be considered by companies when determining how a solution aligns with their IT landscape—on the basis of operating systems, application servers, integration capabilities and database platforms. By combining these types of technologies with supply chain management solutions, companies can make prudent lean business and technical decisions based on current Six Sigma objectives and future strategic direction.

As companies begin to work together, there are still challenges to be resolved, such as:

- Achieving global inventory visibility (GIV);
- Determining where to source inventory to match demand;
- Integrating new business processes into the current work flow;

- Integrating new systems into the current IT infrastructure;
- Determining the least costly method to move inventory through the supply chain;
- Enabling real-time communication with trading partners (i.e., suppliers, carriers, etc.);
- Optimizing labor, warehouses, private fleets and other critical assets across the supply chain;
- Managing the entire order lifecycle from creation to fulfillment;
- Enabling direct-to-customer order fulfillment from the manufacturing source.

### Potential Technology Pitfalls: Is ERP enough?

One common problem in linking to supply chain partners is the incompatibility of internal computer systems with other firm's systems and the Internet. In recent years, many companies have implemented ERP systems to coordinate internal financial, marketing and human resource data. However, most ERP systems are not linked to shop floor production scheduling, inventory and quality control data. This type of information is essential to collaborative production planning and inventory management throughout the supply chain as well as making build-to-order production feasible.

Widespread use of HTML computer language which—although good for transmitting Web pages and other human-readable information—is not optimal for transmitting and processing data. The XML language is a much more computer-efficient language. Many business process platforms are compatible with XML and, as such, efficiently process large amounts of order, schedule, inventory and other related supply chain data necessary to extend lean principles.

# Create Value Throughout the Entire Supply Chain Enterprise.

## How to Use Fundamental Principles in Lean, Agile and Six Sigma

### Characteristics of a Lean System

Even though many definitions of lean exist, there is a consistently strong emphasis on reducing the use of all resources in a company—labor, material, capital, space and time. Lean enterprises are always looking for ways to cut the use of any of these resources in the firm. JIT methods are at the heart of these efforts and include:

- Pull approach and kanban production control
- Inventory reduction
- Quick setups and orders
- Quality at the source (jidoka)
- Supplier networks
- Teamwork and participation
- Continuous improvement (kaizen)

### Pull Approach

JIT uses a pull approach to production scheduling versus the more traditional push method that is based on forecast of demand, rather than the actual demand. In the past, JIT could be implemented in a single factory using kanbans (cards) to alert upstream workstation to produce more of an item. This worked fairly well but was difficult to transfer outside the factory to suppliers who often delivered large batches infrequently because it was not easy to link their production schedules to that of the customer. Some companies overcame this problem by locating their factories in close proximity to the customer, assigning their own employees to work at the customer's plant or using Electronic Data Interchange (EDI). EDI, which links the computer systems of different firms through software protocols, is a closed system which requires substantial investment in software and hardware and thus is not widely deployed, especially among smaller firms.

The collaborative nature of a business process platform is particularly useful for production planning function for it will allow quick notification throughout the supply chain of any disruptions to existing schedules, for example, capacity or material constraints or machine breakdown. The members of the supply chain can then quickly and collaboratively adjust their production plans.

The pull principle of production planning ultimately begins with the last link in the supply chain, the final customer of the product or service. By using such a business process platform to transmit point-of-sale transactions and orders down the supply chain, the member firms can keep their production in line with final demand, reducing inventories throughout the supply chain and avoiding the "bullwhip effect". This process makes it feasible to link the entire supply chain into one long pull pipeline.

### Inventory Reduction

A key principle of lean is reducing inventories to the bare minimum. The effort to do so turns out to be powerful in finding waste and inefficiencies throughout the supply chain. A business process platform is useful in this endeavor as it coordinates the supply chain in order that each participant is only producing what is actually being used at the next stage, not what they expect to use. The result is smaller lot sizes and frequent deliveries meaning low levels of inventory throughout the supply chain.

### Quick Setups and Orders

Another benefit of inventory reduction is that mass customization of a service or product will become feasible for products and services as the supply chain becomes shorter and faster. To be able to deliver mass customization of a service or product, the supply chain must be very fast and responsive. This requires quick setups for production and rapid turnaround on orders to suppliers. As lot and order sizes come down due to the closer coordination of production schedules, companies will be forced to develop faster and more efficient ways of setting up runs of products and order delivery to customers. By allowing closer coordination of production schedules and faster adjustment to changes in demand, a business process platform will facilitate information transmittal internally within the company and externally throughout the supply chain. This process also helps facilitate the ongoing trend of outsourcing and manages the closer cooperation and information sharing among supply chain participants.

### Quality at the Source (jidoka)

Another key principle is jidoka or quality at the source. A business process platform can aid in the implementation of quality improvement in a lean supply chain in several ways. First, internally, it can allow rapid transmittal of quality problems throughout the firm when line or machine stoppages occur. A feature of jidoka that makes it effective is the highlighting of quality deficiencies so that everyone is aware of them and responds appropriately.

The greatest benefit will be spreading jidoka along the supply chain. If immediately notified through a business process platform of a quality problem of a participant, companies can not only adjust their production schedules but also help resolve the problem. Additionally, another supplier may be able to provide the item until the quality problem is resolved.

### **Supplier Networks**

Supply chains are becoming more closely linked where the lines blur between separate corporate entities (i.e., the virtual supply chain). The tremendous amount of information transmittal and cooperation through a business process platform allows firms to link more closely with their supply chain partners.

Supplier partnerships are another important feature of effective lean systems. A business process platform alone cannot create these partnerships. Trust and experience are also required, but it makes it more practical to link to suppliers in production scheduling, inventory control, quality improvement and new product development in a way that could not even be conceived of when lean production systems were first developed in the 1960s.

### **Teamwork and Participation**

Lean production systems call for teamwork and participation of everyone to make them effective. As lean thinking spreads throughout the firm creating the lean enterprise, and along the supply chain creating the virtual firm, even greater teamwork and participation will be necessary. A business process platform will facilitate this as virtual meetings become more widespread and much more information is available to everyone within and outside the firm. As leading experts and others have pointed out, good management decisions are based on data and careful analysis of data, and the information capabilities of a business process platform can disseminate the data. There are many types of information that will allow for better problem resolution and production planning. If firms allow their employees to actively use this wealth of data and to work with employees in other firms in the supply chain, the result should be superior (because of broader participation) and much faster (because data and decision can be communicated quickly) decision-making in the supply chain.

### **Continuous Improvement (kaizen)**

Kaizen is a natural consequence of the other lean characteristics discussed. The philosophy of leanness and lean thinking encourage all employees to continually search for a better way of doing things to improve quality, efficiency and speed. The concepts of zero defects and zero inventories, although unattainable in many cases, are motivating and further improvement is almost always possible. Probably the largest contribution a business process platform can make to kaizen is its ability to rapidly disseminate all types of data (i.e., demand, production schedules and quality performance) that are essential to effective process improvement.

## Becoming Lean and Agile

Two popular paradigms in the supply chain industry are lean thinking and agile manufacturing. Leanness means developing a value stream to eliminate all waste, including time and to ensure a level schedule. Agility means using market knowledge and a virtual corporation to exploit profitable opportunities in a volatile marketplace.

As new paradigms are developed and promoted, there is a tendency to view them in a progression and in isolation. We will demonstrate how supply chain planning, supply chain execution and business intelligence solutions are used to create value when simultaneously considering both lean and agile paradigms.

When business in a supply chain focuses upon the end user, there are many metrics that can be considered. However, they may be aggregated as service, quality, cost and lead time. This presents the total value of a product to the end-user. Within a specific market sector the need for higher levels of service and quality or lower costs and shorter lead times will arise and the metrics will be gauged in different ways. This year's order winner will become next year's market qualifier. One year a business might win more orders by providing improved service, while the following year the business will have to continue to provide this level of service to qualify for the market. These behaviors can be related to agile and lean paradigms, beyond manufacturing, to highlight some of their key features.

### Key Characteristics of Agile and Lean Manufacturing Paradigms

Highlighted are the prerequisite characteristics of the lean and agile paradigms. These can be regarded as essential, desirable or indifferent for a given supply chain strategy to be successfully implemented. Here is the list of the key characteristics. We are first going to define and discuss these key characteristics and then we are going to define the most common supply chain strategies and finally we are going to discuss the impact of these key lean and agile characteristics on each of the supply chain strategies.

- Use of Market Knowledge
- Integrated Supply Chain
- Lead Time Compression
- Eliminate Muda
- Rapid Reconfiguration
- Robustness
- Smooth Demand/Level Scheduling

### Use of Market Knowledge

All businesses in any supply chain must focus on the end user and both paradigms emphasize this point. The nature of the end-user or market sector as a whole will have a direct impact upon which paradigm will be the most apt for any supply chain or part of a supply chain. If market knowledge is not exploited and the supply chain is to be made more responsive, then the members run the risk of, for example, producing too wide a variety of products at short notice when there is insufficient demand to justify the extra cost.

### Integrated Supply Chain

Businesses must work together to form an integrated supply chain focusing on meeting the demands of the end user or final customer of the supply chain no matter what paradigm is adopted. The goal of an integrated supply chain is to remove all boundaries to ease the flow of material, cash, resources and information. With the integrated supply chain, both the information and material flows will be simplified, streamlined and optimized, reducing waste and lead times.

### Lead Time Compression

In recent times, lead time compression has become a major order winner. Leanness calls for the elimination of all waste or in lean terminology, "muda". This means the elimination of anything that is not adding value to a process or service. By definition, this includes waste time. Therefore, time compression is essential for lean manufacturing. Likewise, agile manufacturing requires a responsive supply chain. This also calls for lead time compression in terms of information flow as well as material flow.

### Eliminate Muda

Lean manufacturing is called lean as it uses less, or the minimum, of everything required to produce a product or perform a service. Leanness achieves this by eliminating all non-value adding processes. In a pure lean supply chain there would be no slack and zero inventory. It would be very impressive, although not realistic, if zero inventory throughout a total supply chain, was achieved. However, focus on eliminating muda throughout the supply chain is indeed critical to improve the efficiency of the supply chain.

### Rapid Reconfiguration

Agile manufacturing and by extension, an agile supply chain, means that the supply chain process must be able to respond quickly to changes in information from the market. This requires lead time compression in terms of flow of information and material and the ability, at short notice, to change to a wide variety of products. As such, the ability to rapidly reconfigure the supply chain process is essential.

### Robustness

An agile supply chain must be able to withstand variations and disturbances and indeed must be in a position to take advantage of these fluctuations to maximize profits.

### Smooth Demand/Level Scheduling

An effective lean environment avoids the requirement for robustness by calling for the demand to be stable through the use of market knowledge, information and forward planning. Lean supply chains, by their very nature, tend to reduce demand variation by simplifying, optimizing and streamlining the supply chain. However, if the end-user demand is beyond the control of the supply chain it will not be possible to implement lean principles at the interface with the end-user. Sudden variations in demand would lead to waste either in not producing near capacity or needing to keep larger buffer stocks.

We have now defined and discussed key characteristics of a lean and agile supply chain. These characteristics have differing importance depending on the specific supply chain strategy a company leverages to drive profit.

### Key Lean and Agile Characteristics Differentiated by Supply Chain Strategies

Here are the most commonly used supply chain strategies.

- Buy to Order (BTO)
- Make to Order (MTO)
- Assemble to Order (ATO)
- Make to Stock (MTS)/Ship to Stock (STS)

Figure 3 represents the family of simplified supply chain structures/strategies with the decoupling point marked as a stock holding point. The decoupling point separates the part of the supply chain that responds directly to the customer from the part of the supply chain that uses forward planning and a strategic stock to buffer against the variability in the demand of the supply chain. The positioning of the decoupling point therefore depends upon the longest lead time an end-user is prepared to tolerate and the point at which variability in product demand dominates. Downstream from the decoupling point all products are pulled by the end-user, that is, they are market driven. Upstream from the decoupling point the supply chain is initially forecast driven (i.e., push). We are now going to discuss a few of the supply chain structures highlighting the key characteristics defining a successful implementation of lean and agile paradigm.

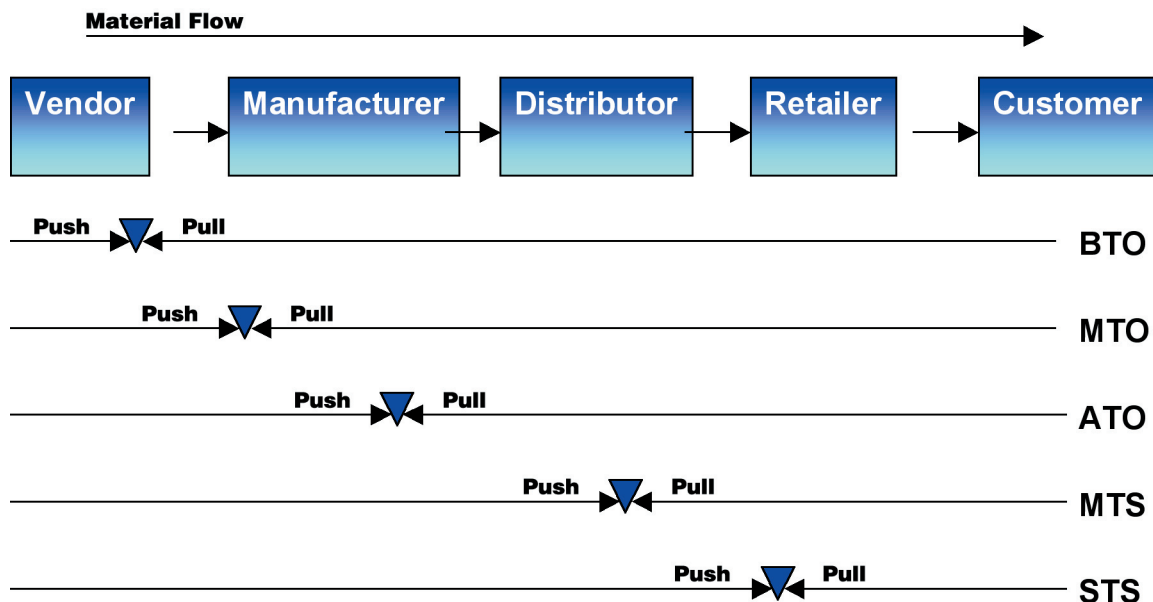


Figure 3: Supply chain strategies structures

### **Buy to Order (BTO)**

BTO is an appropriate supply chain strategy if all the products are unique and do not contain the same raw materials, where the end-user is prepared to accept long lead times and the demand for products is highly variable. If the supply chain held any stock, it would run the risk of them becoming obsolete. If a particular product did not succeed in the market place then this supply chain would not have any exposure to the costs of overstocking. However, the supply chain would not be able to take advantage of new markets quickly.

### **Make to Order (MTO)**

With a MTO structure a supply chain is able to change to different products as long as they are made from the same raw materials. It will also cope with varied locations, volumes and product mixes. The lead time will be reduced but the end-users might still have to accept a considerable wait to get the product they desire. The demand for the product can be variable and with a high level of customization both in terms of number of different combinations and the amount of the basic model that will need to be customized. A MTO structure is exposed to the risk of holding raw materials and components in stock.

### **Assemble to Order (ATO)**

With an ATO supply chain structure customization is postponed until as late as possible. The ATO supply chain will be able to respond to a varied product mix from within a range of products, whether customized or not. The lead time will be reduced considerably and will depend upon where in the supply chain the final assembly takes place. This slightly increases the risk of overstock or understock but the products will not be of the same value as the assembled product. Thus, the supply chain is protected against the full risk of obsolescence. Conversely, the supply chain will be in a better position to take advantage of a product ascending the growth stage of its lifecycle.

### **Make to Stock (MTS)/Ship to Stock (STS)**

Both MTS and STS supply chain strategies represent cases where a standard product is provided from a defined range. The MTS strategy means that the supply chain can cope with demand in varied locations but calls for a steady overall demand of a standard product. The STS strategy provides a standard product in fixed locations. The members of the supply chain must be able to forecast demand accurately if they adopt these two strategies. It is critical that they are aware how accurate their forecasts are and hold the correct level of stock to minimize the risk of stockouts and overstocks.

Lean and Agile concepts, as discussed in this section, are important methodologies to blend together to drive value in an extended supply chain. Even though the genesis of these concepts are from the manufacturing domain and were derived independently they are directly applicable to the extended supply chain. Just as Lean and Agile concepts, when thought of together, drive value to the extended enterprise Lean and Six Sigma concepts, when considered simultaneously will also drive value.

## Lean Management and Six Sigma

Six Sigma and lean management have diverse roots. The key issue driving the development of Six Sigma was the need for quality improvement when manufacturing complex products having a large number of components, which often resulted in a correspondingly high probability of defective final products. The driving force behind the development of lean management was the elimination of waste.

Both Six Sigma and lean management have evolved into comprehensive management systems. In each case, their effective implementation involves cultural changes in organizations, new approaches to production and to servicing customers and a high degree of training and education of employees, from upper management to the shop floor. As such, both systems have come to encompass common features, such as emphasis on customer satisfaction, high quality and comprehensive employee training and empowerment.

With disparate roots but similar goals, Six Sigma and lean management are both effective on their own. However, some organizations that have embraced either Six Sigma or lean management might find that they eventually reach a point of diminishing returns. That is, after re-engineering their operating and supporting systems for improvement by solving major problems and resolving key inefficiencies, further improvements are not easily generated. These organizations have begun to look elsewhere for sources of competitive advantage. Naturally, lean organizations are examining Six Sigma and Six Sigma organizations are exploring lean management. The term "lean Sigma" has recently been used to describe a management system that combines the two systems (Sheridan, 2000).

Progressive manufacturing enterprises will be able to build responsive and agile manufacturing operations synchronized with the associated supply chain network structure that profitably meets real customer demand, rather than merely making efficient use of manufacturing resources, with the lowest costs being the measure of success. Traditionally, the determination of profitability and responsiveness is the inventory buffers to counter unpredictable manufacturing performance couple with variable demand. Processes that result in a quick response to change while maintaining control of operations through the use of Six Sigma concepts will become the indispensable manufacturing advantage.

"Six Sigma can be applied to any business process. It is often useful to think of lean as identifying waste and Six Sigma as the technique used to help measure the variation in order to eliminate the waste in the process. Use of Six Sigma is not a requirement in the journey to be lean, but many companies use it to measure their process improvements across the extended value stream."

Judy Sweeney, AMR Research,  
"Lean Manufacturing, Part I: Introduction," January 4, 2006

As lean manufacturing is becoming more combined with Six Sigma, the ability to access and analyze the information to understand variability becomes critical. Where the data resides is not necessarily the challenge, it's the ability to set standards, access data related to those standards in real time and then measure those standards to Six Sigma so the improvement initiative can be executed properly. The advantages of lean manufacturing combined with Six Sigma techniques throughout the supply chain deliver:

- Real-time supply chain communication and coordination;
- Real-time transportation information;
- Inventory reduction through demand-based replenishment;
- Reduction of waste internally and externally;
- Improved demand signal management across the entire network;
- Focus on creating pull material flow across the entire supply chain.

The next figure shows the achievable benefits with just a one sigma (standard deviation) improvement. Imagine how much more effective a company can compete with a three or four sigma improvement.

| One Sigma Increase In         | Yields (Percent Improvement) |
|-------------------------------|------------------------------|
| Margin improvement            | 20%                          |
| Increase in capacity          | 12%-18%                      |
| Reduction in employees        | 12%                          |
| Reduction in capital expenses | 10%-30%                      |

Source: *Six Sigma: The Breakthrough Management Strategy Revolutionizing the World's Top Corporations*, by Mikel Harry and Richard Schroeder (Doubleday, 2005)

## Overview of Six Sigma

The roots of Six Sigma can be traced to two primary sources: total quality management (TQM) and the Six Sigma statistical metric originating at Motorola Corporation. Today, Six Sigma is a broad, long-term, decision-making business strategy rather than a narrowly focused quality management program.

From TQM, Six Sigma preserves the concept that everyone in an organization is responsible for the quality of goods and services produced by the organization. Other components of Six Sigma that can be traced to TQM include the focus on customer satisfaction when making management decisions, and a significant investment in education and training in statistics, root cause analysis and other problem solving methodologies.

The Six Sigma metric was developed at Motorola in 1987 in response to sub-standard product quality traces. Traditionally, design engineers used the "Three Sigma" rule when evaluating whether or not an acceptable proportion of manufactured components would be expected to meet tolerances. When a component's tolerances were consistent with a spread of six standard deviation units of process variation, about 99.7 percent of the components for a centered process would be expected to conform to tolerances.

With Six Sigma, the value of an organization's output includes not just quality but availability, reliability, delivery performance and after-market service. Performance within each of the components of the customer's value equation should be superior.

## Summary

The real bang for lean return on investment is achieved by extending lean concepts through the entire supply chain. This comes from the improved execution activities of the entire business, not just the manufacturing operations functions. The benefits of extending the lean methodologies and techniques throughout an interdependent supply chain network typically are multiplicative, relative to the benefits derived from a single enterprise deploying the same tools solely at the shop floor level.

Meeting the requirements of customer-driven demand with its implied uncertainty and variability through multi-echelon supply networks is not a small undertaking and will take time, especially for the required change in mindset. Manufacturers must start now by building a cross-functional team to define their manufacturing and supply chain network strategy, and designing a roadmap for deployment of Supply Chain Planning and Supply Chain Execution applications that incrementally build manufacturing and supply chain agility.

### Getting Started

- Evaluate each supply chain process as to applicability of lean concepts, both enterprise and cross-enterprise. Transportation and procurement are generally good starting points.
- Include major suppliers, customers and partners as lean concepts move from enterprise to extraprise.
- Partner with IT vendors to deliver and sustain value.
- Consider new supply network while deploying lean concepts.
- Build mutually beneficial relationships with partners to share information and synchronize planning activities driven by customer demand characterized by pull demand concepts.
- Build the correct supply network, including the supply side component, to prevent stock out, excess stock buffers, and replenish on demand.
- Strive for agile, same-day manufacturing execution capabilities with minimal variability in order to meet real customer demand.



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