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Filling the Gap

Rethinking supply management in the age of global sourcing and lean

Has your company jumped onto the global sourcing bandwagon? Have you launched a drive to "lean up" raw material, work in process (WIP), and finished goods (FG) inventories? If so, you've probably noticed something you didn't anticipate. Specifically, order fulfillment—that process that used to run so smoothly—is getting difficult to manage. And in today's environment this can be a big problem.

If you are unable to deliver products to the market in a flexible and timely fashion, your competition will get the sale instead.

Managed properly, global sourcing and asset reduction are initiatives that can lead to significant financial improvements. But both are double-edged swords since they also pose significant order fulfillment risk. Few companies involved in rolling out these initiatives, however, have acknowledged this by changing their approach to supply chain order fulfillment.

Why does this blind spot exist?

The answer can be found by examining the gold standard of modern manufacturing practice—the Toyota Production System (TPS), now popularized as lean manufacturing. Although original equipment manufacturers (OEMs) have successfully applied TPS principles, many still experience relatively high rates of failure in order fulfillment. In other words, in spite of being lean, they still find themselves unable to get the right product to a customer when that customer is ready and willing to buy it. This is because OEM supply chain dynamics have changed significantly (see table 1) whereas TPS was developed primarily as an inward-looking strategy.

At-a-Glance

- For many manufacturers, order fulfillment—being able to deliver product to market quickly and flexibly—has been dramatically affected by lean initiatives, global sourcing, and asset reduction.
- A key reason for this impact on order fulfillment is that the Toyota Production System was based on an inward-looking methodology—and supply chain dynamics have changed considerably since its introduction.
- What's needed is a way to fill the gap: an extension to current practice that focuses on manufacturing critical path time-based proactive supply chain management.

Table 1: Changes and impacts

The change	The impact
OEM operations are increasingly dependent on highly processed purchased material instead of commodity products.	Sourcing of OEM purchases cannot be quickly redirected, as it could for commodity products.
Purchased content of OEM's products has risen significantly.	OEM operational effectiveness increasingly depends on supply chain order fulfillment capability.
Suppliers are no longer located near customers, as assumed in TPS.	Distance increases supply interruption risk and decreases supply flexibility.
Asset reduction initiatives have led OEMs to adopt build-to-demand strategies.	Suppliers must support higher magnitudes of OEM order variability.
The market is more demanding. Mass customization is replacing inventory-based product offerings.	Obsolescence is accelerating. Building ahead carries significant market risk.
Competition is greater. Customers expect instant gratification.	Alternate products are available. Companies that cannot provide products in a timely manner will lose sales.

Table 2: Then and now

That was then	This is now
OEM forecasts were set annually and updated infrequently. Suppliers scheduled "level production."	OEM forecasts are revised in real time. Suppliers must vary quantities and mix on a daily basis.
Suppliers were given forecast "firm zones." Suppliers built ahead.	Firm zones are being reduced. Building ahead puts suppliers at financial risk.
OEM order fulfillment was based on prebuilt inventory buffers. Demand variation was satisfied with FG.	OEMs have minimal FG inventory. If suppliers cannot support OEM schedule variation, sales are lost.
With buffers in place, lost production could eventually be made up with overtime.	Seasonality of build-to-demand products can max out supplier capacity. Without FG inventory, insufficient production means lost sales.
Production was limited to a small number of models, allowing mass production-based batch builds.	The market commands more options. Demand is increasingly variable. Demand quantity for each model does not support large batch builds.

TPS was based on a highly localized supply chain in which suppliers held excess assets in support of lean OEM customers, as in the keiretsu model. Today, even if suppliers remain willing to prebuild inventory in support of OEM operational needs, the distance involved with global sourcing prevents this strategy from being an effective solution. Most OEMs try to tackle this issue by beefing up their logistical and warehousing functions, but this represents a partial solution at best (see table 2).

If beefing up logistics and warehousing represent only stop-gap measures, what is the answer? First, it must be recognized that the inward focus of the TPS represents a significant gap, and OEMs that want their products to be considered world class need to look outside of their own factory walls in planning to be lean. Second, we must acknowledge that current supply management practice does not provide the extended enterprise perspective necessary for understanding the lean supply chain.

What is needed is an extension to current practice—which we will explore here.

MCT: a key metric

POLL A GROUP of supply management professionals on what is meant by supplier lead time and you will hear dozens of definitions. This should raise a red flag about this term, especially in a world where order fulfillment is paramount. On closer examination there is a second concern. Distill the definitions into a single one and you'll likely come up with a traditional definition along these lines: the amount of time from when an order is transmitted to a supplier until that order is received by the customer.

The problem is that nowhere does this definition address how the supplier fulfills the order. In other words, supplier lead time focuses strictly on a result. Because of this it must be regarded as a reactive, not a proactive, metric.

What is needed instead is a supplier lead time indicator that focuses on both the outcome and how the outcome is achieved. Manufacturing critical path time (MCT) is this type of metric: the typical amount of calendar time from when a manufacturing order is created through the critical path until the first, single piece of that order is delivered to the customer.

The key here is measurement through the critical path. Specifically, assume the supplier does not stock any WIP or FG inventory. Then time the raw material from the beginning of the order through all office and factory processes, including typical batching and queuing times along the way, plus logistics times, until it arrives at the customer's factory. By not relying on WIP or FG inventory, MCT provides a true reflection of a supplier's order fulfillment capability, that is, the "how."

Would adopting MCT as a metric of how lean a supplier is undercut current supply management practice? The answer is no. Just as supplementing the TPS with an

extended enterprise perspective doesn't mean having to rewrite TPS, MCT dovetails nicely with traditional supply management metrics.

OEMs typically employ a triad of supplier performance measures: quality, delivery, and price. Much like the traditional supplier lead time metric, these three focus on end result, not giving any indication about a supplier's strategy for obtaining their performance. Pairing up MCT with quality, delivery, and price gives a flavor for how suppliers achieve performance, as follows.

> TPS was based on a highly localized supply chain in which suppliers held excess assets in support of lean OEM customers, as in the keiretsu model.

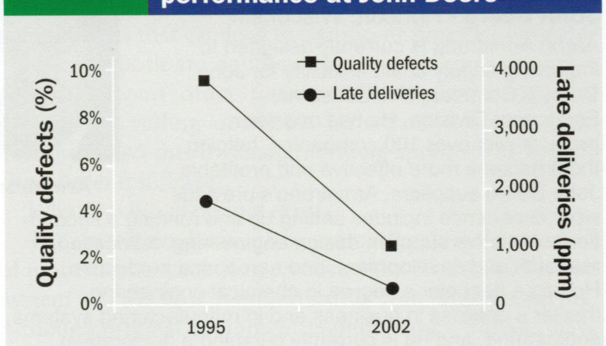
MCT and quality. A supplier with high quality ratings paired with long MCTs indicates a higher probability of inspection and sort or rework. On the other hand, a supplier with high quality ratings and short MCTs doesn't have time for sorting or reworking. Knowledge of both metrics paints a more complete picture about supplier internal processes.

MCT and delivery. Suppliers with long MCTs achieve high delivery ratings by shipping from FG inventory since they lack the flexibility to support changes in schedule. High delivery performance in conjunction with short MCTs is indicative of a lean supplier with ability to react quickly and reliably.

MCT and price. Competitive pricing associated with long MCTs raises a red flag about a supplier's long-term viability. Since long MCTs also are associated with excessive nonvalue-added activities, competitive pricing may indicate the cutting of infrastructure and/or investments for the future. Competitive pricing and short MCTs indicate minimal waste and a higher probability of a financially healthy supplier.

In all these cases, knowledge of both metrics paints a more complete picture about supplier internal processes and true order fulfillment risk. More important, the implication of these arguments is that shortening MCTs in the supply base should result in better supplier performance. This has been the key to a lean supply chain initiative at John Deere, an organization that uses MCT reduction as the driver. During phase one of this initiative, the MCT was reduced by an average of 78 percent across the supply chain and resulted in the supplier quality and delivery improvements shown in figure 1.

Figure 1: Impact of MCT reduction on supplier performance at John Deere



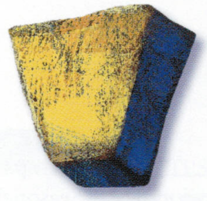
Quick-response manufacturing

HAVING MADE THE case that short MCTs are integral to supply management, how can OEMs and their suppliers achieve MCT reduction? The answer is, through quick response manufacturing (QRM). QRM was designed from the ground up as a strategy that pursues the reduction of MCT throughout an extended enterprise. Among existing strategies for achieving lean, QRM is uniquely positioned to tie OEMs together with their suppliers for flexible, asset-optimized support of variable customer demand.

You may well ask, "Why QRM? Isn't this re-inventing the wheel? Couldn't we apply one of the more popular lean strategies to the order fulfillment problem? Why do we need an alternative?"

It is true that these popular lean strategies have produced impressive results. But they are also inward focused, and their successes have been within individual organizations rather than through supply chains. This is primarily because the TPS strategy on which popular lean approaches are based is focused on waste reduction, and that tends to be more of a local issue. The focus of QRM is on time reduction. And since time both lends itself to a more global outlook and is the primary driver of order fulfillment, QRM is better positioned to support lean supply chain management. Also, as we have seen, this focus on time still yields the reduction in waste that is at the heart of all lean strategies.

There are additional ramifications of the difference in focus between QRM- and TPS-based approaches. For example, key TPS principles of takt time, level scheduling, and kanban all break down in the face of higher



variability. Yet an effective supply base must withstand demand variability without performance degradation. QRM and its MCT metric are better suited for managing demand variability.

QRM is based on four core concepts.

1. The power of time. While everyone knows that "time is money," QRM teaches that time is a lot more money than you might realize. Long MCTs create many unseen costs such as time for meetings required to change priorities, time spent by sales, planning, and other departments to update forecasts, expediting of hot jobs or late orders, and so on. Significant reductions in MCT can shrink or even eliminate these costs. Although accounting systems do not predict this (since no direct tie has yet been established between MCT reduction and cost reduction in those systems), results from QRM implementations consistently show significant reductions in cost associated with MCT reduction.

2. Organization structure. Elimination of functional silos is a second fundamental QRM principle. Although there is already a trend in industry toward implementing cells, QRM solutions are more flexible, involve more ownership, and go beyond the shop floor. Also, it is imperative to rethink performance measures in a QRM environment. Traditional focus on use and efficiency must be replaced, with MCT reduction becoming the primary metric.

3. System dynamics. QRM decision makers must understand and then exploit system dynamics effects. This strategy parallels the thinking that purchasing managers must consider in design of supply chains for effective order fulfillment. Understanding system dynamics means taking into account the impact of batch sizes on MCT. System dynamics also point out the need for investing in spare capacity, a strategy which leads to a second QRM metric, response capacity (which we'll examine a bit further on). QRM provides simple analysis tools and an understanding to help make these and other tradeoff decisions.

4. An extended enterprisewide approach. Unlike TPS-based lean strategies, QRM is not just an inward-looking, shop floor approach. It provides tools for material planning, shop floor control, office operations, new product development, and other areas such as human resources. It is an approach to lean that lends itself to breaking down organizational barriers, both internally and among companies. It does this by bringing all stakeholders together to focus on overall MCT reduction. This high-level focus can provide a unifying factor to the more traditional "localized" lean efforts. Typical TPS-based lean activities are rooted in lower-level waste elimination, which segregates value chain lean activities.

Understanding *how* suppliers achieve performance is just as important as the performance achieved.

In summary, TPS-based lean strategies have not lent themselves to the extended enterprise perspective required for effective order fulfillment in the era of global sourcing and asset reduction. Just as MCT supplements—but doesn't replace or make obsolete—traditional supply management metrics, QRM provides an important extension to traditional lean strategies and places a new context on supply chain management.

Global sourcing and total acquisition cost

TO CONNECT THIS discussion to the issue of global sourcing, remember that MCT includes logistics time from the supplier's factory to the customer. Hence the MCT value helps in evaluating true costs of global sourcing. Low piece prices available from overseas sources may be fool's gold if they result in lost sales or other costs associated with order fulfillment breaks.

Total acquisition cost (TAC) typically has been quantified in terms of piece price and best-case scenario logistics cost, failing to account for lost profitability due to forecast inaccuracies plus costs of expediting. Companies are beginning to realize that global sourcing involves significantly more than this.

Trying to take all of the contingencies into account in a TAC formula represents an overwhelming task. Companies have attempted this and ended up either wallowing in massive computations or abandoning the approach completely. An alternative is to take a higher-level view and tie order fulfillment risk-based costs to MCT. John Deere has done just that: Its TAC formula quantifies these costs directly through MCT—the longer the MCT, the higher the cost penalty. Deere's TAC risk factor differentiates among suppliers with different length MCTs, regardless of whether the variances are due to lack of being lean internally or long logistics times. By applying this factor, the TAC calculation drives the need for suppliers to be lean and gives visibility to the higher order fulfillment risk associated with global sourcing.

Companies that wish to employ MCT risk factors should consider several key issues. These include market demand variation, forecast accuracy, cost of production downtime due to supply chain nonperformance, cost of lost sales due to supply chain breaks and inflexibility, and length of product life cycle.

A new strategy

BY QUANTIFYING THE TAC risk factor we also can evaluate the benefits of a powerful new strategy that combines the best of two worlds, global sourcing and order fulfillment risk management. Under this strategy the OEM sources part of the demand for a component from an overseas supplier for low piece price and puts up with a high MCT for that portion. The OEM then sources the remaining demand from a lean domestic supplier with low MCT, planning for additional capacity with this supplier to provide for flexibility contingencies. Are there significant benefits to going to this trouble? The result is overall more competitive pricing, but without the normal order fulfillment risks.

Typical of the results John Deere has found employing this strategy, an overseas supplier had a piece price of $19 and a 10-week MCT, while a domestic supplier offered a price of $27.85 with a one-week MCT. Simulations with different demand scenarios showed that if the OEM went 100 percent with the overseas supplier, the TAC actually would be $23.02, significantly higher than the quoted price. Going completely with the domestic supplier yielded a TAC of $28.52. However, this was not the solution either. Sourcing 70 percent from overseas and 30 percent domestically resulted in the optimal TAC of $24.64. Thus dual sourcing based on MCT and TAC gave substantial price advantage over conventional sourcing, yet provided the order fulfillment flexibility necessary to support variable demand.

World-class manufacturing needs to account for the lean state of entire supply chains. Understanding how suppliers achieve performance is just as important as the performance achieved. Similarly, we need to consider the order fulfillment risk associated with extended supply chains. MCT is a precise, meaningful metric that supports extended enterprise supply management in multiple ways.

Order fulfillment planning and product life cycle

THE PRODUCT DEVELOPMENT process traditionally has been conducted at arm's length, both among OEMs and their suppliers, as well as within OEMs through a series of handoffs between internal functional silos. The role of the supplier was to manufacture parts to print, as designed by the OEM.

Recently OEMs have made efforts to break down the silos, and supply chain integration is bringing suppliers into the product development process at a point where they can contribute beyond executing established designs. Even with this change, however, supply chain order fulfillment is rarely brought up as a topic during the product development process.

This gap is being accentuated by global sourcing and asset reduction. Supply chain design in support of order fulfillment is best addressed by several functions that should occur during the product development process.

Marketing. Supply chain order fulfillment parameters need to be defined as part of a product's specification. Two such parameters are seasonality ratio and flexibility ratio. Seasonality ratio is the highest forecast monthly production volume divided by the expected annual average monthly production volume. Flexibility ratio is the quantity of parts that a supplier needs to be able to deliver, after a specific order firm zone, divided by the quantity in the original forecast, for example, 1.25 for a three-month period, after two weeks firm. Knowledge of these ratios allows suppliers to plan their order fulfillment support. Suppliers should document their commitment to supporting these ratios as a prerequisite to participation in the product development process.

Supply management. OEMs should specify the seasonality and flexibility ratios on their formal request for quote forms. In their actual quotes, OEMs should ask suppliers for their projected MCT as well as their response capacity—the supplier's maximum sustainable monthly production. Based on knowledge of a supplier's response capacity and MCT, an OEM then can determine whether a supplier is planning order fulfillment support based on build-to-demand capability or on some build-ahead model, and use this information to decide if the supplier's operational plans merit additional scrutiny.

Design engineering. The risk of order fulfillment error increases relative to production load, so engineering changes should be minimized during peak production periods. Also, for products with high seasonality or flexibility, suppliers may plan for some level of pre-built product, so engineering changes also should be minimized in the period just prior to peak production. Whenever product safety or significant functionality deficiencies are at issue, change is allowed. For all other changes, an engineering change management control period should be defined, which will dictate whether or not changes may be implemented.

Practical implementation

THE STRATEGIES DISCUSSED here are more than just theoretical propositions. John Deere has been rethinking its approach to supply chain order fulfillment since 1994. Since then, most of these strategies have been put into practice. A follow-up article, featuring a case study illustrating the practical application of these concepts, will be published in an upcoming issue of *APICS* magazine. The case study will demonstrate the positive impact of MCT-based proactive supply chain order fulfillment planning on operations and financials. ◆

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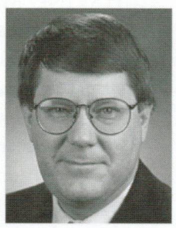

Ericksen

Ericksen has been with John Deere for 29 years. In 1995, he launched a supplier-development pilot initiative based on a strategy of Manufacturing Critical-path Time (MCT) reduction. Because of its success, it has been adopted across the entire Deere enterprise. Ericksen is founder and former chair of a Wisconsin-based original equipment manufacturer supplier-development consortium that created a supplier-training program for Wisconsin manufacturers. The consortium recently launched a third-party supplier-development initiative based on MCT as a metric of supplier leanness. Ericksen is a well-known writer and speaker on supply chain order fulfillment.

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El-Jawhari

As a manager, El-Jawhari restructured the Commercial & Consumer Equipment Division's supplier-development strategy to ensure order-fulfillment continuity and flexibility in the face of reduced assets and increased product seasonality and volumes. The strategy's success has been benchmarked by companies such as Honda of America and General Mills, and it is being deployed to other John Deere divisions. El-Jawhari now is providing recommendations to the division's executive leadership to further reduce assets and increase asset turns throughout the order-fulfillment process. El-Jawhari holds a Ph.D. in industrial engineering and a master's in manufacturing systems engineering from UW-Madison.

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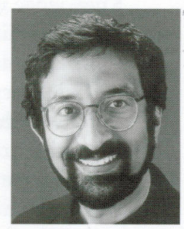

Suri

Suri is professor of industrial engineering at the University of Wisconsin-Madison and director of the Center for Quick Response Manufacturing. He authored the book *Quick Response Manufacturing: A Companywide Approach to Reducing Lead Times*. Suri has an M.S. and Ph.D. from Harvard University and a bachelor's degree from Cambridge University. He has consulted for leading firms including Danfoss, IBM, John Deere, Rockwell Automation and Trek Bicycle. Assignments in Europe and the Far East have given him an international perspective on manufacturing competitiveness.

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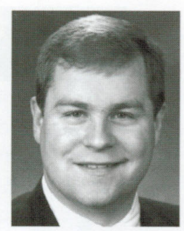

Armstrong

Aaron Armstrong is currently assigned to improving supply chain flexibility for John Deere's Commercial & Consumer Equipment Division. He has overseen projects with over 100 companies, helping them become more effective and profitable John Deere suppliers. Armstrong's previous work experience includes setting up and running a second-tier automotive supplier, design engineering, fabrication, research and development, and aerospace production. He has a bachelor's degree in chemical engineering, master's degrees in business and in manufacturing systems engineering, and he is currently pursuing a doctorate in industrial engineering, all from the University of Wisconsin in Madison.