How to improve your inventory deployment

Inventory is still hard to control, especially as distribution channels proliferate and customer service demands increase. And while there’s no “silver bullet” solution to getting the right amount of goods to the right place at the right time, supply chain managers can take steps now to improve their inventory deployment. This effort begins with a rigorous analysis of the root causes of stocking problems, more detailed inventory classifications, and the application of sophisticated analytical tools.

By Jeff Metersky and J. Michael Kilgore

Despite all that has been done to streamline supply chains, inventory management remains a significant challenge in most organizations. New multichannel business models are a big factor. For example, look at how retail giant Target takes orders across all its divisions and fills them from shared inventory, or how companies like Buy.com use a virtual business model, which lets them hand off physical distribution to their partners. At the same time, more and more manufacturers are choosing to go direct, bypassing distributors and retailers. Channel proliferation often has an unfortunate outcome: multiple pools of inventory that drag inventory turns downward.

Compounding the challenge is customers’ growing appetite for more specialized products, which has resulted in an explosion in the number of SKUs and a growing need for tailored service levels. Technology is proving to be as much a hindrance as a help, here. Companies used to assign customers to a specific fulfillment point and ship all orders “complete” from that location. Now, thanks to technology, it’s possible to ship, track, and receive split orders and shipments. As a result, part of an order can be shipped from a regional facility, and the remainder from a central facility or even from a supplier’s location. While these additional options provide a huge opportunity to improve fill rates and service levels, they also add complexity.

A fortunate minority of businesses can still get by with current, rudimentary approaches to inventory deployment. But many companies possess formidably complex supply chains; they face inventory-planning decisions across thousands of items in multiple stocking locations, for example, or they offer an array of fulfillment options ranging from make-to-order to vendor-direct ship. For these companies, it is increasingly necessary to use more sophisticated, analytical processes to help with inventory-deployment planning.

Most successful manufacturers and retailers do pay attention to how and where inventory is deployed. But their efforts are often insufficient for combatting rising supply chain complexity. Typically, businesses do not review inventory deployment often enough, or in enough detail, or with a complete enough picture of the total costs. Conventional inventory allocation and visibility systems become Band-Aids as most companies don’t have a clear strategy for determin-
ing the best item-level inventory placement or stocking targets to meet service levels. The consequences? Missed opportunities to reduce inventory, improve service levels, and reduce operational costs.

If you were to analyze system-wide inventory at the item and location level, you would find that most companies could reduce their inventory by 10 to 50 percent. Consumer-packaged-goods conglomerate Gillette, for example, used more sophisticated analytical techniques to slash inventory by 24 percent, and oil-products company Castrol cut inventory by 40 percent while improving fill rates by 5 to 8 percent.

Now that it’s possible to route orders anywhere, from any location, companies must consider where to put inventory in the first place—or whether to hold it at all. This article charts the dimensions of the inventory challenge. It identifies the problems that persist with conventional approaches and recommends four steps to achieve more effective inventory-deployment planning.

The Problem with “Band Aids”

Each day, businesses make countless decisions on how to move inventory through manufacturing operations, distribution centers, and transportation networks to end customers. These decisions are often being made subjectively and arbitrarily as new products are added, as customer requirements change, or even as capacity is reached at an existing facility. The jumble of inventory decisions lacks clear policy objectives and, as a result, can lead to excess inventory, missed opportunities to reduce order-fulfillment costs, and customer service imbalances with companies overserving some customers while underserving others.

When it comes to inventory planning, supply chain managers are often guilty of using a “rearview mirror” approach that lacks durability and adaptability. They place inventory without understanding the relationship between replenishment costs, inventory carrying costs, and fulfillment costs; they set inventory levels without understanding the characteristics of demand or supplier leadtimes; and they set customer service levels without knowing the profit contribution and relationship between revenue, lost sales, and required inventory investment.

Current tools don’t help much. Enterprise resource planning (ERP) solutions and distributed order management disciplines allow companies to assign orders to inventory that is anywhere in the supply chain network. While such flexible order management may enable companies to reduce backorders and lost sales, it often comes at a high operational price. When businesses tackle a specific inventory problem, they often launch programs that lead to excess inventory and high logistics costs companywide. And in the end, these programs may still fall short in terms of customer service.

Too often, managers rely on supply chain visibility and distributed order management tools that address only the symptoms of inventory problems. While distributed order management may circumvent order failures and produce higher fill rates, the results may not hit the bottom line. Why? While many execution and visibility systems offer short-term solutions, such as allocating inventory to a pressing order, they
fail to solve the problem's root cause. These systems will allow a company to pay premium freight costs to ship inventory from Chicago to an Atlanta customer when its Georgia facility is out of stock. But they don’t explain why the inventory wasn’t in the Georgia distribution center in the first place. Nor do they prevent the stock-out from reoccurring.

Automatic replenishment systems aren’t the answer, either. A replenishment application can effectively execute the reorder policies and sourcing guidelines that a company provides it. But it does little or nothing to decide where inventory should be held and which customers and channels should be served from each location. (Such placement decisions might seem insignificant, but they helped one leading high-tech company save more than $1 billion over a decade.)

Complicating the deployment decision even further is the fact that the wrong metrics help produce the wrong behaviors. Companies struggle to make the right trade-offs between service levels, inventory investments, and operational expenses. All too often inventory-reduction initiatives are focused on increasing turns, but at what cost? While lean concepts and lower inventory levels are valid objectives, they are not always the best measurements of value. Increasing inventory velocity will lower inventory carrying costs and reduce storage requirements, but these gains often come at the expense of increased order-fulfillment and logistics costs. (The sidebar below explains the total cost view of inventory.)

The bottom line is that even if a company’s inventory decisions are right 95 percent of the time, the misplaced 5 percent can be costly. Improving inventory policies and placement on this small percentage can save millions of dollars.

The problem is that today’s deployment strategies are too basic. Companies may use sophisticated tools and methods to forecast demand, replenish inventory, move it through the supply chain, and link it to orders. But most lack equivalent sophistication in the design of strategies to deploy inventory. Rather than looking at where to place inventory in the first instance, they fall into the following traps:

- **Trying to solve the problems at too high a level.** To determine stocking strategies, many companies use simple classification methods that group items by volume or revenue. But those methods don’t consider variability of demand or lead-time. As a result, highly variable items receive the same recommended stock levels as those that have stable demand. In addition to oversimplified item classes, companies often over-generalize service levels—assigning the same set of policies for all customers, items, or channels. These basic inventory placement approaches almost always underestimate or over-estimate required stocking levels, thereby undermining service levels and increasing fulfillment costs.

- **Missing the total cost perspective.** Managers frequently fail to look at all the costs associated with filling an order. (Exhibit 1 shows what costs need to be considered.) For example, a company might decide to relocate its inventory to regional locations to begin providing one-day service. But instead it could have stored the inventory centrally and changed its transportation mode to next-day airfreight, possibly at much lower total inventory-carrying cost. Managers also often let preconceived notions drive faulty conclusions. They may assume that transportation costs will rise more than inventory will decrease as product moves farther from demand, so they don’t consider an option because it will raise costs in one area even though it lowers total costs.

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**The Total Cost View of Inventory**

To design a supply chain that balances costs and service levels while reducing risk, managers have to understand the relationships among the major elements of their overall supply chain operating costs. These costs include: inbound transportation costs, outbound transportation costs, fixed and variable facility costs, and inventory carrying costs. (See Exhibit 1.)

When a business adds production and distribution facilities, its inbound transportation costs will increase because each shipment becomes smaller and more frequent. At the same time, placing inventory in more locations—closer to customers—means that outbound delivery costs decrease. Yet as inventory is decentralized, carrying costs increase because leadtime variability at any one location increases, which forces an increase in the amount of safety stock required to meet service levels.

The internal operations of additional facilities create extra inefficiencies. As businesses add larger facilities, they often see diminishing returns. These large facilities have significant variable costs because simple interior moves, like taking a pallet from receiving to shipping, require significantly more labor. There is also a significant duplication of resources and administrative effort.

Of course, these costs must be evaluated against their relationship to service levels. More stringent fill rates and leadtime requirements can hike up transportation and inventory costs. So if a company increases its service delivery from two days to overnight, the transportation cost to provide that increased service will significantly increase, making a decentralized network more appealing. As firms alter service requirements, the cost relationship will shift—as will the curves that determine the optimal centralized and decentralized network decisions.

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**EXHIBIT 1**

**Costs That Need to be Considered**

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<thead>
<tr>
<th>Network Cost Drivers</th>
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<tbody>
<tr>
<td>Transportation Costs:</td>
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<td>Inbound</td>
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<td>Delivery</td>
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<td>Inventory Costs</td>
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<td>Total Costs</td>
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*The internal operations of additional facilities create extra inefficiencies.*
Using basic math to solve PhD problems. Of the few companies that have created inventory-deployment planning processes, most have simplified their calculations by assuming simple averages for demand and leadtime. As a result, they overlook variability and seasonality and lock in placement decisions before they adequately understand the required stocking levels. Failure to factor in supply variability can easily lead to safety-stock levels that are too low to meet service guidelines (Exhibit 2 illustrates how this can happen.) Too often, the tools companies use for complex decisions are nothing more than spreadsheets and what-if analyses—tools that ignore the large universe of stocking alternatives.

Making location and policy decisions separately. To optimize inventory placement, companies must consider an extraordinarily high number of options that trade off the impact of placement on stocking levels and logistics costs. Without the proper tools and approaches, companies overwhelmed by the complexity of so many options often make the decisions sequentially, first choosing inventory-holding locations, then assigning customers to be served from those locations, and then applying stocking strategies at each location. The problem with that approach: no opportunity to evaluate different location combinations that might reduce overall costs.

A Four-Step Approach
Most managers can use performance indicators to quickly diagnose an inventory-deployment issue—too many stockouts or back orders, for example, or inventory arriving late to stocking locations and leading to expedited handling and freight. But can they do more than identify the symptoms of poor inventory planning? Can they pinpoint and evaluate the drivers of inventory problems? In all likelihood, no. What’s needed is a comprehensive inventory planning process that will help companies to determine: where to place inventory, in what form to hold inventory, how much inventory is needed, and what level of service to provide. Through optimal deployment planning, a company can evaluate different service policies (such as 95-percent product availability or next-day delivery) by customer or channel segments and choose the mix that yields the best service-profit relationship. A company’s total inventory investment and fulfillment costs can be designed to maximize profitability.

We have found that businesses can develop an optimal inventory-deployment plan through a sequenced four-step methodology. This methodology rapidly reviews all possible alternatives and presents recommendations that minimize total costs or maximize profits. It can identify optimal inventory placement, set best stocking and service-level policies down to the item level, and enable the flow of material through multi-tiered supply chains.

The methodology does not substitute for other supply chain operating frameworks such as distributed order management; in fact, it can work in tandem with these frameworks to thoroughly evaluate options for storing inventory while still guaranteeing service levels. Similarly, companies still need network optimization to design their supply chain infrastructure, using inventory-deployment planning later to model optimal inventory placement within that infrastructure.

The sections that follow provide an overview of each of the four phases of the inventory-deployment planning methodology. For best results, companies should complete the first two phases before moving on to the final phases of the approach.

Analyze the Root Causes
The first step in developing an inventory-deployment strategy is to identify what’s causing the company’s inventory headaches. One distributor with multiple stocking locations and tens of thousands of SKU’s set out to discover the cause of incomplete orders from its primary distribution center (DC)—a glitch that led to out-of-region deliveries and increased freight costs. The analysis identified that nearly half of the out-of-region shipments were the result of inventory-deployment decisions (stockouts at the primary DC accounted for 35 percent, and decisions to not hold product at all locations accounted for another 15 percent).

A root-cause analysis, like the one performed by this distributor, involves two distinct initiatives:
- Trace the true cause of symptoms. Managers have to catalog the factors that are causing inventory problems such as stockouts, out-of-region freight, or obsolescence. Outside of poor deployment planning, companies should list other potential triggers—operational procedures, supply chain infrastructure, or information systems, for instance—and quantify the frequency of each causal factor. This can be a simple or complex exercise that requires a cross-functional team to identify the possible causes. For example, when a company sees that items aren’t shipping from regional facilities, a cross-facility team must be assembled to determine all of the possible causes, whether they relate to customers, policies, vendors, or systems. Once the possible causes have been
determined, transactional data can be analyzed to determine the actual cause for each occurrence. Tallying the number of occurrences will allow the business to attribute causes to problems the next time an out-of-region shipment occurs.

- **Determine the size of the deployment-planning opportunity.** By segmenting out the costs and symptoms that can be affected by a new deployment strategy, companies can calculate the potential opportunity in terms of inventory reductions, operational cost savings, and service-level enhancements. For example, in the case of the distributor cited earlier, a simple change in inventory policy can substantially reduce out-of-region shipments.

2. **Decompose the Item Data** Next, it’s necessary to break down and reclassify products and customers based on common attributes. There are two steps:

- **Create inventory product-family classifications.** If individual products aren’t classified correctly, deployment strategies won’t yield optimal, or even good, results. Before modeling inventory placement, a company must classify items into inventory-deployment families (IDFs) based on three sets of characteristics: product, demand, and supply. (Exhibit 3 gives sample inventory-deployment families.) These IDFs are an improvement over traditional ABC classification. Using simple ABC classes, two $100 items with an average demand of 10 units each would be given the same class and thus stocking policies. But a quick look at demand variability exposes the flaw in this approach. Item A’s daily demand varies from 6-12 units, and item B’s demand ranges from 1-50 units—therefore requiring far more inventory for the same service level. IDFs would allow for this variability and set stocking policies differently for each. IDF classification could permit thousands of unique product families compared to up to 100 for traditional ABC classes.

- **Segment customers and channels.** Similar classification can apply to customer characteristics such as channel type or fill-rate requirement. To create differentiated service-level policies, companies must group individual customers based on their common service characteristics of fill rates and order cycle times. Rather than assigning fill-rate policies to products, target fill rates should be based on the unique characteristics of that channel or customer. For example, one channel might have a fill rate of 95 percent, while another channel has a 99-percent rate. So rather than setting a fill rate at an average 97 percent or a maximum of 99 percent, companies should consider each customer’s unique service requirements and demand characteristics. Imation, a global technology company, was struggling with high inventory costs associated with serving customer overseas facilities. By applying an optimal deployment strategy and segmenting its customers, Imation was able to reduce investment by 20 percent, gain a 25-30 percent improvement in getting products to market, and improve item-level fill rate to 98 percent.

3. **Apply Serious Math** Root-cause analysis and data classification often result in complex mathematical relationships. Supply chain managers can take certain steps to quickly solve these relationships.

The preliminary step is to choose the right mathematical model and tools to plan your inventory deployment. Because demand level and demand variability are primary considerations for setting optimal safety-stock levels, it is critical to accurately model demand variability at the item level. To do so, companies must evaluate an item’s demand and leadtime distribution during a replenishment period and apply the appropriate probability distribution model. For example, companies often assume that leadtimes are normally distributed. But in practice, replenishments are more often late than early—violating the assumption of normal distribution. It is equally important to select the right distribution model for demand. If an item’s demand is sporadic, then a Poisson distribution model might best fit its demand pattern.

All relationships between where to stock and how much to stock must be modeled simultaneously to determine the optimal locations and quantities down to the item level. The next step is to decide on the short-listed alternatives produced by the analytical model. At this stage, inventory deployment planning becomes a task for senior managers. When the policy affects customer service, the planning and modeling aspects must be spearheaded by someone with the authority to plan across the network and make company-wide recommendations.

### Where to Stock: The Influence of Demand

To effectively determine where to place inventory, a company must model all of the possible location combinations to understand the cost to service demand from each location. If a company has three distribution centers, it has eight possible
stocking combinations: stocking in none (that is, following a make-to-order or direct ship strategy), in any one of the three, in any two of the three, or in all three locations.

To make the right decision, the model must not only consider the location of the inventory but also the optimal assignment of replenishment sources and the optimization of service territories. First it's necessary to analyze logistics costs. A company must evaluate the cost to replenish inventory and serve demand from each location and ultimately use those costs to determine where inventory will reside in the network. This requires consideration of inbound and outbound transportation costs, facility handling and processing costs, and demand profile constraints such as shipment size and customer leadtime, while respecting available storage capacity at each facility.

It's also crucial to factor in customer leadtime requirements. Locations that can’t serve customers within the expected leadtimes can be ruled out at once. For example, if a national distributor offers certain clients next-day guarantees, then it can only centralize items that can feasibly be shipped next-day air (less-than-truckload (LTL) or truckload service from a central location could take as long as five days). We know of a high-tech vendor that reduced the number of its facilities from 30 to 14 by expanding its use of parcel shipping. That change eliminated $30 million of inventory-carrying costs.

**How Much to Stock: Variability and Fill-Rate**

At the same time as it is modeling inventory location, companies must also model how much to stock. An item-level safety-stock policy can be derived by analyzing:

- **Demand variability.** As the number of customers assigned to a location changes, so too does the demand level and the demand variability. These changes significantly alter the optimal inventory-level requirements. As a company consolidates inventory into fewer locations, individual products will typically ship with greater frequency. This increase in frequency lowers demand variability, increases the predictability of order size and timing, and thus decreases required safety-stock levels. (See Exhibit 4.) For example, consider an item that currently averages three shipments a month at each of its 10 stocked locations. Each location must hold enough inventory to cover an order arriving on any three of the thirty days. But if the product was stocked in only one location, the company only needs enough inventory to support, on average, one order per day (and the likelihood of all orders occurring on the same day is small). Having a single stocking location results in having a more predictable demand pattern, which means less stock is required to meet a given service level.

- **Supplier leadtimes.** When products are assigned to a new location, the length and variability of replenishment leadtimes can change, thus altering the inventory requirements. Changes in leadtimes are typically driven by the physical locations of suppliers and the modes of transportation used to replenish stocking locations. Shorter or more certain lead-times require lower inventory levels at a stocking location, while the opposite is true for highly variable leadtimes. For example, consider an item currently stocked in Atlanta and Chicago that’s replenished by a Los Angeles supplier. Assume that average replenishment leadtimes are five days but can be as high as eight days. Now consider that instead of stocking in these two locations, the product is stocked only in Los Angeles, reducing the average replenishment leadtime to one day with little variability. This reduction in leadtime and variability allows the company to hold lower levels of inventory because it can be replenished much faster. The savings can be significant. For example, by reducing supplier leadtimes from 12 to five weeks, Epson, a manufacturer of printers and imaging products, was able to reduce inventory by 68 percent and stockouts by 75 percent.

- **Fill rates.** To determine how much inventory to hold, a company must consider each customer’s item fill rate—the percentage of time that stock is available when an order is placed. The larger the fill-rate percentage, the higher the inventory required to meet service levels. With greater product availability comes greater working-capital needs and inventory costs but also greater revenue potential as lost orders are reduced. The key here is for the company to balance the cost of lost sales vs. the cost to serve for each location and item. By reconsidering their fill-rate policies, compa-
nies can differentiate between customers and minimize the inventory investment for the least profitable customers and items. We know of a healthcare distributor that used optimized deployment to redefine its inventory policies and was able to eliminate half its safety stock as a result.

- Review periods. The more often a company reviews its inventory and places replenishment orders, the less inventory it must hold. Why? Because it is reducing the window between when demand spikes might occur and when inventory can be replaced. But with more frequent reviews come increased ordering costs and smaller order quantities, which leads to larger transportation costs and missed opportunities for quantity discounts. The key is to understand the optimal review period, minimizing the combined working-capital and replenishment costs in light of all the other factors.

Personalizing the Shortlisted Alternatives
After reviewing possible inventory locations and amounts, let’s say that the analytical models come up with five strong alternatives for inventory deployment. Furthermore, all of them minimize cost and limit the overall risks of service disruption from, say, a dock strike or a warehouse fire. Which option should a company choose? At this point, senior managers must review the alternatives with a view toward balancing operating costs and working-capital needs. A more centralized stocking strategy will improve the balance sheet and net profit, but it will increase transportation expense. As a result, there is growing interest in the concept. The next few years promise to be exciting as researchers gain ground in the quest for tools that can solve complex inventory-deployment equations. The academic community, in particular, is researching the techniques and technology required to perform a global solve for all of the costs and constraints required. Within two or three years, some of this research may yield commercial alternatives.

Don’t Wait for the Silver Bullet
There is no one tool that can do inventory-deployment planning—not yet, anyway. The current selection of off-the-shelf software for network design and inventory optimization falls short of solving the inventory-deployment problem in its entirety. Traditional network-optimization tools can balance the costs associated with the physical flow of product—transportation, storage, handling, and so forth. But they cannot adequately capture the variability of demand and leadtimes and the consequent nonlinear relationships associated with optimizing inventory levels. And while inventory-optimization applications have made great strides in setting stocking levels, they cannot readily handle large combinations of placement alternatives. So today, inventory-deployment planning requires a custom solution or process that combines the capabilities of network-optimization and policy-optimization tools in an iterative method.

But the discipline of inventory-deployment planning is taking shape, and industry leaders such as ON Semiconductor, John Deere, and Kellogg’s are showing good results by applying the discipline. As a result, there is growing interest in the concept. The next few years promise to be exciting as researchers gain ground in the quest for tools that can solve complex inventory-deployment equations. The academic community, in particular, is researching the techniques and technology required to perform a global solve for all of the costs and constraints required. Within two or three years, some of this research may yield commercial alternatives.

Supply chain professionals cannot afford to wait for breakthrough solutions, however. There is much that can be done today to reframe the inventory discussion. Managers can dig deeper into root-cause analysis and go further in reclassifying products and channels and customers. And they can adapt available tools to begin solving their most pressing inventory-placement and policy decisions.

Most importantly, they can start thinking of inventory deployment as a necessary management discipline and not just a warehouse-by-warehouse project. It is not a job to be handed off to a junior supervisor—it has to be an ongoing strategic initiative led by a senior manager and with accountability to finance and operations executives.

This article has not tried to give a one-size-fits-all answer to companies’ complex inventory challenges. Rather, it has attempted to give supply chain managers a clearer picture of the factors they must think about as they strive for overall inventory efficiencies. The next steps—the actions needed to realize efficiencies—are for those managers to make.

Companies should not assign fill-rate guidelines evenly to all locations and items; instead, they should use this analysis as a chance to reconsider the relationship between lost sales and the cost to serve.