A New Model for Solving, and Resolving, Inventory Problems

INVENTORY

Inventory is a wonderful thing. Inventory allows us to meet seasonal spikes in demand with level annual production. Inventory allows us to offer a wide range of products and options while manufacturing in large, efficient batches. Inventory allows us to provide high order fill rates, despite random variations in demand, and to continue production despite random variations in supply. Inventory even allows us to decouple, and optimize, sequential production processes. Yes, inventory is a wonderful thing.

But, you know, nothing is free. For all of the benefits inventory provides, we must pay a lofty price. Inventory is a hungry beast. Inventory consumes shelf or floor space. Inventory steals our flexibility and robs us of future opportunities. And inventory devours our working capital.

We profess to be inventory managers, but some could argue we are lion handlers, attempting to train—though never tame—the savage beast. Using the tools of the trade, blank-pistols, chairs, and whips, we cause the lion to sit on the pedestal or jump through the hoop, all for the benefit of our customers and the enrichment of our enterprise.

But enough of the analogies. What are the tools of the inventory management trade? Before we can select the appropriate tool, we must clearly understand the task to be performed. What are some typical inventory problems?

I asked this question at the 1999 conference, and I will ask it again now. By a show of hands, how many of you have had, at one time or another, too much inventory? Now, who, at one time or another, has not had enough of some inventory item? And, who has had too much of something and not enough of something else at the same time? Well, it looks like defining our inventory problems might be a little complicated.

THE CLASSIC CAUSE AND EFFECT DIAGRAM

A good tool to use in a situation like this is an Ishikawa diagram, also known as a cause-and-effect diagram or a fishbone diagram. We will state our problem, “inventory turns are down compared to the same period last year,” in the head of the fish. This is the “effect.” Next we will list the major possible causes as branches off the spine. Comparable periods, computations, excess inventory, and insufficient sales, among other possible causes, will be added. For each major cause, we now add all possible minor causes. For example, under comparable periods, we might look for abnormalities in the two periods—last year and this year. In each of these, we might look for changes in either inventory or sales plans. We might find that there was an unusually large sale last year caused by a new customer placing their initial stocking order. If our policy is to remove atypical events, then our failure to do that was the cause of the problem. If we don’t have a policy of removing atypical events, then the cause of the problem is the lack of the policy. Assuming we have such a policy and continuing further back, we might find that insufficient procedure documentation, or inadequate employee training, was the root cause of the problem. The cause-and-effect diagram is an excellent tool to help us identify the root cause of a simple problem.
AGGREGATION

But first, let’s go back to our problem. How can inventory turns be down while backorders are up? Everyone knows that the more inventory we have, the greater the probability that we will have enough of the right item to satisfy the customer. The concept is so simple that even sales people understand it. How many times have you heard a salesperson complain that they could have sold more if only you had had more inventory? Have you ever heard a salesperson complain that we had too much inventory? Of course not! Complaining about too much inventory is an accounting function. So how can inventory turns be down while backorders are up?

Remember the formula for inventory turns—annualized cost of goods sold divided by the average inventory? There are two problems with this formula. First, what is our average inventory? Is it year-end, month-end, or average daily available inventory? It doesn’t really matter, as long as we are consistent and the result is an unbiased approximation of our actual inventory. Next month, record your actual daily inventory level and see if the average is within a couple percentage points of the “official” number you use to calculate your inventory turns. If not, why not?

The second problem with the inventory turns formula is, who says the stuff being sold is the same as the stuff sitting in stock? It could be we are selling red widgets as fast as we can make them, with the difference going on backorder, while the blue widgets are gathering dust and sucking up working capital.

This is the problem with aggregation. We lump a bunch of different things together and pretend they are all the same. Folks, if they were the same, they would have the same stockkeeping unit (SKU). You gave them different SKUs because they are different.

THE BALANCED INVENTORY

Let’s look at the red and blue widgets. Imagine we are producing equal quantities of each, but that the current demand for red widgets is twice the current demand for blue widgets. Assuming our total production is equal to the total demand, we are accumulating excess blue widgets while failing to satisfy demand for the reds. And that’s probably the best-case scenario! If our total production does not equal the total demand, we are driving our system even more out of balance.

Balance. That’s a nice word. As inventory managers, we are trying to balance supply with demand. A balanced inventory is one in which the ratio of available SKUs is the same as the ratio of demand for those SKUs. If the demand for red and blue widgets is 67 percent and 33 percent, respectively, then our available inventory should also be 67 percent and 33 percent. We could call the quantities that these percentages represent our inventory targets. For example, if total demand for the replenishment cycle is 600 widgets, we would set an inventory target of 400 red widgets (two-thirds of 600) and a target of 200 blue widgets (one-third of 600).

THE TWO-HEADED FISH

Back to our problem. If we are producing red and blue widgets at a ratio not equal to the demand ratio for widgets, our inventory will soon be out of balance. But what caused the problem and how do we correct it? We can use our fishbone diagram to determine the root cause of the problem. Let’s say that in this case it was a failure to include a seasonality factor in our forecast. We sell the same number of red and blue widgets every year, but we sell more of the reds this time of the year.
and we sell more of the blues about six months from now.

Changing our forecasting formula to include seasonality will resolve the long-term problem, but it won’t help us with our short-term problem of backordered reds and excess blues.

I believe that all inventory problems can be divided into two groups: shortage and excess compared to target. A late delivery is a shortage. An early delivery results in excess. A poor quality part is a shortage of a good quality part, and it’s also an excess of rework or scrap parts. Of course, any imbalance between supply and demand results in either shortage or excess inventory.

Shortage and excess may share a common cause, but the short-term solutions will always be different (except, perhaps, for the ultimate inventory out-of-balance solution, which is bankruptcy.) We need to modify our fishbone diagram.

With apologies to Mr. Ishikawa, I call this the two-headed fish diagram, with one head for shortage and another for excess. The single tail indicates that there could be a common cause for the problems, though there is no guarantee of that.

SHORT-TERM SOLUTIONS FOR SHORTAGES AND OVERAGES

The heads have whiskers, which represent possible short-term solutions. For instance, offering an off-season discount is one of many possible solutions for our excess inventory of blue widgets. Canceling open purchase orders, or unreleased work orders, might be another. For shortages, expediting orders, alternate sourcing, or even raising the selling price could be a possible solution. There is no common short-term solution to both excess and shortage.

This is why it is important to disaggregate inventory prior to analyzing it. We don’t want to offer discounts on stuff we don’t have, nor do we want to expedite stuff we already have in excess. The simplistic statement, “Widget backorders are up. Get more and have them expedited,” is an example of the failure to properly segregate and analyze shortages and overages.

INVENTORY MANAGEMENT AND INVENTORY CONTROL

Just as I believe that all inventory problems can be divided into shortage and excess, I am confident that all root causes of inventory problems can be divided into two categories: methods and data accuracy. I use the terms “inventory management” and “inventory control” to distinguish between these.

That is the difference between inventory management methods and inventory control accuracy?

Managing inventory involves setting policies and making both strategic and tactical inventory decisions. Inventory management is a cross-functional activity. Examples of inventory managers are buyers, planners, supply chain managers, product managers, marketing managers, operations managers, and presidents of companies. Usually these are exempt positions.

Very few inventory decisions are made by actually looking at the inventory; usually, the decisions are made by looking at a perpetual or book inventory in our computer. The perpetual inventory attempts to mirror the actual inventory, though sometimes in an asynchronous mode. A buyer does not walk the warehouse looking for items that have dropped below the reorder point painted on the wall. Rather, the computer monitors the level of all items and notifies the buyer when an item falls below the reorder point set in the computer.

One of the decisions inventory managers will have to make is the acceptable level of accuracy required in the system. They may use a Pareto chart or activity-based costing (ABC) analysis to classify items into different accuracy tolerance groups. For example, “A” items should be exact, “B” items plus or minus two percent, and “C” items plus or minus five percent. Inventory managers would then allocate the resources to achieve these objectives, such as initiating cycle counting or empowering a receiving clerk to quarantine a shipment for a 100 percent count if acceptance sampling indicated a problem.

Inventory control involves all the activities necessary to ensure that the perpetual inventory is within the established tolerance levels of the actual inventory. One way this is done is by posting transactions to the perpetual inventory whenever something happens to the real inventory. Receipts, disbursements, movements, and consumptions are examples of inventory transactions.

Generally, the people responsible for inventory control are the often non-exempt people who perform or supervise inventory transactions. Receiving and shipping clerks, quality inspectors, cycle counters, stockroom personnel, and warehouse managers are all responsible for inventory control. They need the tools, training, authority, and motivation to ensure good data accuracy. It is ironic that some of the most expensive decisions inventory managers will make will be based upon data maintained by some of the lowest-paid people in our organization.

Good inventory control, or inventory data accuracy, includes more than just accurate inventory transactions. It includes the accuracy of all data
necessary to make inventory decisions. Maintaining accurate bills of material, lead-times, lot sizes, safety stock values, reorder points, units of measure, and costs are all functions of inventory control data accuracy activities.

Methods are the tools we use to manage inventory. Examples of methods are the exponential smoothing method of forecasting or the use of the mean absolute deviation (MAD) to measure the forecast error. reorder point (ROP) and materials requirements planning (MRP) are methods of replenishment. Methods are the things we do to manage inventory. A root cause analysis might indicate that we used the wrong method and that we should have used weighted moving average rather than exponential smoothing, or we should have used mean absolute percentage error (MAPE) rather than MAD, or we should have used MRP rather than ROP.

When deciding which method is most appropriate, and when using the method, we generally assume that our data is within an acceptable tolerance. For example, we accept the planned orders in our MRP system because we assume that the inventory quantities, bills of material, and other data are accurate. In summary, inventory management is the decisions we make assuming accurate data. Inventory control is the things we do to ensure our data are accurate.

DIFFERENT ROOTS NEED DIFFERENT RESOLUTIONS

It is not enough to identify that the root cause was a bad forecast. We must also determine if the forecast method, or the data itself, was in error. The long-term, corrective actions we implement will depend on the answer. We cannot solve an inventory control problem with an inventory management solution, nor vice versa.

For example, when we discovered that our red and blue widget production, and our inventory, was out of sync with demand for the products, we investigated and found that the cause of the problem was that we failed to consider seasonal demand fluctuations. But is that a problem of inventory management or inventory control?

Let’s imagine that we recently switched from a moving average to an exponential smoothing forecast because we wanted to minimize the amount of data we had to maintain. If that decision caused the problem, then we need to either switch back to a moving average or modify our exponential smoothing method by incorporating a seasonality factor. The problem was in inventory management. If, on the other hand, we had been using a seasonality factor but a data entry error caused us to use an incorrect value, then the root cause would have been a failure of our inventory control system.

A TWO-TAILED FISH

We now see why our fishbone diagram should have two tails—one for inventory management methods and one for inventory control accuracy. For each possible cause of our problem, we must ask ourselves whether we are using the right method and whether our data are accurate. To ensure we always consider both possibilities, I recommend we draw our fish with two tails.

An incorrect method, such as the wrong forecasting technique, can result in either shortages or excess inventory. Likewise, bad data can also result in either a shortage or an excess. Since either of the two general causes of inventory problems can result in either of the two general types of problems, we need to link the two tails to the two heads with a common neck.

THE INTEGRATED MODEL

Ishikawa’s elegant fishbone diagram has mutated into a rather ugly creature. I have agonized over this and, after much consideration and a couple glasses of fine Sonoma County wine, I have decided to replace the fish with a wrench.

For lack of anything more imaginative, I call this a wrench diagram. The four points of the wrench remind us of the two root causes of all inventory problems and the two possible effects of the problem on our inventory. The common shaft, or handle, reminds us that either failures of inventory management methods or inventory control accuracy can lead to either excess inventory or an inventory shortage (see Figure 1).

BACKORDERS AND STOCKOUTS

When we do not have the inventory item we need, I believe it is critical that we know if our inventory system “thought” we had it. I have found nothing in the literature, or dictionaries, regarding this distinction. I suggest we use the word “backorder” to indicate that our inventory system agrees with our physical inventory and that we have none available. We could use the word “stockout” to indicate that our inventory system shows available inventory when, in fact, there is none. Backorders can be anticipated, and replenishment stock should already be on order. Stockouts, however, cannot be anticipated. We will need to correct our data and expedite a replenishment order. Stockouts are far more devastating than backorders because the recovery period is longer. The distinction
is even more critical in a make-to-stock environment. Backorders will be obvious in our available-to-promise (ATP) system, and we will have been able to give the customer an expected future delivery date. For stockouts, however, we have already promised delivery, and we must now go back to the customer and explain that our promise was based on invalid data. If we do that often enough, we won’t have any customers to worry about.

Backorders are part of inventory management while stockouts are a failure of inventory control.

Let’s look at some examples of how we can use our inventory wrench.

THE CASE OF THE MISSING CONTROL PANELS
We attempt to issue 10 control panels to production, but the stockroom reports there are none available. Our inventory system indicates we should have 12 control panels in the stockroom, so this stockout appears to be an inventory control issue. (If our perpetual inventory had also listed none available, then it would be a backorder and not a stockout.)

We investigate and discover that the control panels are only used in our Model 5010 widget. Further, we find that we produced 12 model 5010s last month on a priority basis, which means working overtime. We also find that there is no record of issuing the control panels to this rush order, but it did ship on time, and we have had no customer complaints of missing control panels. Asking the final assembly supervisor about the job, she recalls that they had to open the stockroom on a Saturday to get the control panels. She assumed the paperwork would be handled the following week. This shortage is clearly a failure of our inventory control system.

THE CASE OF THE EXCESS PENS
The variance report for an annual physical inventory listed 564 promotional pens counted while the perpetual inventory had been only 47, an overage of 517 pens. The pens were not recounted while the inventory was frozen, because they were “C” items. By the time the major “A” and “B” variances had been investigated, 45 pens had been sent to the marketing director for distribution at a trade show. The auditors investigated and found only 24 pens still in stock—not the 518 pens that should have been there after the shipment. Is this a shortage or an overage problem? Was it caused by a failure of inventory management or inventory control?

It turned out that the people used to count the physical inventory were drafted from a department outside the warehouse and were not familiar with the units of measure. The pens were received, stocked, and shipped in units of measure of a box of 12 pens, but the inexperienced counters had incorrectly entered a count of 564 (47 boxes of 12 pens each). Later, when the ship order for 45 was printed, the warehouse crew, more familiar with the goods, knew to pick and ship 45 boxes of pens, leaving two boxes, or 24 pens, in stock.

The root cause of the problem was the use of inexperienced counters, without adequate training or supervision, for the annual physical inventory. This was a failure of inventory...
management, not inventory control. The short-term solution is to adjust out 517 units, leaving two units in stock. A couple long-term resolutions of the problem might be to improve documentation, training, and supervision for inexperienced inventory counters on future annual inventories, or, better yet, to replace the annual physical inventory with a daily cycle count program performed by trained staff.

THE CASE OF TOO MUCH INVENTORY

Last year, we installed a new enterprise resources planning (ERP) system, and one of the justifications for the ERP system was that it would help us reduce inventory, but inventory has not been reduced.

Upon investigating, we learn that most items are purchased in economic order quantities (EOQs). The EOQ formula, we know, includes the order cost. Prior to conversion, we used $50 as our order cost, but we estimated it would fall to $25 with the new ERP system. We now realize that we failed to change the value and recalculate our EOQs as part of our conversion process. Since we used inaccurate data in calculating our order size, the excess inventory was caused by an inventory control failure. System conversions are an important time to question, validate, and revise both inventory management methods and inventory control accuracy.

THE CASE OF THE NEW PRODUCT BACKORDERS

We recently replaced our model 5120 widgets with model 5125. We expected demand to be the same for the new product, but demand skyrocketed, and the product quickly went into backorder. Our forecast was revised upward, additional work orders were released, and additional raw material was ordered from our supplier. A few months later, demand for the 5125 was back at the old 5120 level, we had excess 5125s in finished goods, and we were attempting to cancel purchase orders with our supplier.

An analysis of the situation revealed that our estimates of initial demand failed to include pipeline inventory. Pipeline inventory requirements should have been included in the launch forecast. Not doing so was an inventory management failure.

THE CASE OF THE BAD DELIVERY DATES

Last fall, the customer service manager complained that the available-to-promise (ATP) dates in the system are past due. Shortages from Asia were displayed with recovery dates that had already passed. We investigated and found that containers from Asia were delayed well beyond their normal transit time due to a lockout and subsequent work slowdown at west-coast ports of entry. Rather than use our standard transit time, we had to manually enter estimates provided by our freight broker. This failure to adjust “standard” transit times to match changes in the real world was a failure of our inventory control system, which is ultimately responsible for the accuracy of all data in our inventory management system.

SUMMARY

An inventory problem must be solved in the short-term, the root cause must then be determined, and a long-term resolution must be implemented. If the problem involves an aggregate inventory, it must first be disaggregated to ensure that we are not mixing excess and shortages together. The short-term solutions for excess are completely different than the short-term solutions for shortages. Similarly, root causes of inventory problems will be either incorrect methods or inaccurate data. It is important to clearly identify the true root cause before attempting to implement a solution. Inventory management “solutions” will not cure inventory control problems, nor vice versa.

I hope that the inventory wrench model will provide a framework to help you better understand the complexities of inventory management and inventory control.

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