



The Inventory Diet Lot Size Inventory and the EOQ Formula

by Duncan McLeod

In the last article I called lot size inventory muscle inventory. Remember: lot size, safety stock, work in process, and investment inventory are all muscle inventories. The rest is sludge or fat.

This is a good black and white definition, but it may not tell the whole story. This month we will take a closer look at using Economic Order Quantity (EOQ), and highlight some tips to make it work for you.

A lesson in Lot Size Obesity

When you make or buy larger lots than you use, you have lot size inventory. Excess lot size inventory should be considered fat. But how much should you have? How much is reasonable to carry?

I got my first lot size lesson back in 1970. I was young, untrained, and a just a bit naïve. In my uncle's mind that qualified me to do the purchasing and material planning for his pots and pans company.

One of my first buys was the cartons for our new fondue pot. We had the first electric fondue on the market back in 1970 and it was going to be a hot item.

If you have ever bought corrugated cartons, then you know there are significant quantity price breaks. I needed 1,000 cartons, but if I bought 2,000 there was a 5% discount, and even better if I bought 5,000, then there was a 10% discount.

With a name like McLeod, how could I turn down a 10% discount? Easy. There was a 15% discount for 10,000!

After they arrived my uncle took me to the warehouse, so I could get a clear picture of what 10,000 fondue cartons looked like, and then added a few choice words to make sure the lesson sank in.

It did.

We only used 2,000 of those cartons before the design changed—the rest went into land fill (we didn't recycle in those days).

Experience taught me a lesson: too much at any cost is still too much. There had to be a better way. I licked my wounds for a couple of weeks and then stumbled across the Economic Order Quantity (EOQ) formula.

Lot Size goes Scientific with EOQ

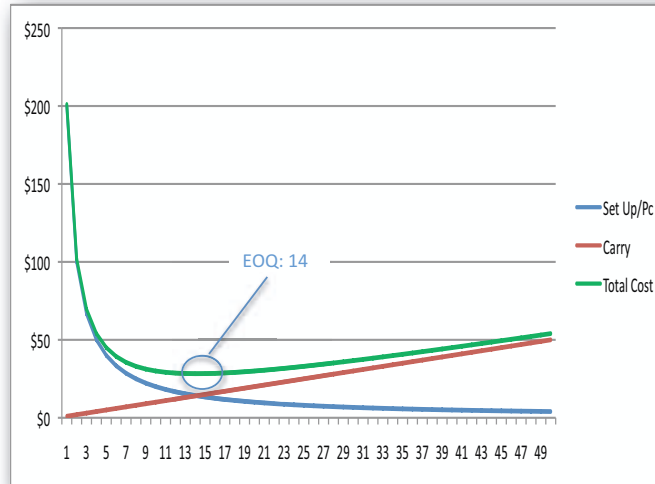
EOQ was a scientific approach to calculating the optimal lot size. And there was algebra and calculus involved! With this kind of math behind it, it had to be good.

The EOQ formula tries to balance the competing forces of setup and carrying cost. The longer the run, the lower the setup cost per piece (the fondue carton logic).

If the setup cost is \$200 and you make one piece, then the setup cost per piece is \$200. If you make 10 pieces, then the setup cost is only \$20 per piece, and so on. Simple math. At 10,000 fondue cartons, the setup cost per carton was getting pretty low—which made the price seem so attractive.

However, we had to carry those cartons for a long time and most of them became obsolete. The lesson: The more you make the more you have to carry, and there is a cost to carrying inventory.

Adding setup cost to the carrying cost gives us the total cost per lot. The following graph shows what this total cost looks like. It starts high and then decreases as the lot size increases. At some point it starts to increase again as the increased carrying costs offset the reduced setup costs. The low point on the Total Cost curve is the EOQ.



The calculation for EOQ is:

$$EOQ = \sqrt{2 * Annual Usage * Setup Cost / (Unit Cost * Carrying Rate)}$$

The logic seemed solid but I had already been burned once, so I decided to do a bit more research. I found that many people were unhappy with their results by blindly applying the EOQ formula.

Looking deeper I found the problem was not the formula, but the variables:

- Carrying Rate represents all of the costs related to carrying inventory: finance or interest costs, insurance costs, warehousing costs, damage and obsolescence costs. The assumption is that these costs can be allocated to a specific part number, that they are variable costs and that they are predictable. Here are a couple of common examples of where these assumptions break down:
 - Storage costs are not variable or linear. Excess space in the warehouse means there is no "space" cost if we add inventory. However, if the next unit of inventory overloads the warehouse, the space cost is very large. The carrying cost calculation is only valid within a range of space (or inventory level).
 - Obsolescence costs are different and difficult to predict. For example, I thought we would be making that same fondue pot forever!
 - Inflation is often not considered. Years ago, I was planning and buying steel coil. At that time, the price of steel was going up faster than the other carrying factors. If I included inflation in the formula, the carrying rate became negative—in fact we made more money on steel price increases than we did on production. Do the math; if the carrying rate is negative, then the EOQ is infinite. That's a lot of steel!
- Setup Cost is a fixed and unchangeable number. The Toyota Production System (TPS) changed the whole concept of setup cost. Using SMED (Single Minute Exchange of Dies) we saw setups go from hours to under 10 minutes. Do the math again. If the setup cost goes to zero, then the EOQ is zero—which really means one! Reducing setup cost and hence lot size inventory is a major lean opportunity.
- Annual Usage is based on historical usage. Shouldn't it be based on future usage?
- Unit Cost must always ask if standard, actual, and variable costs are fully loaded in the application. There are some good accounting questions related to what cost should be used in the formula.
- The "2" in this equation is pretty solid.

EOQ in Perspective

So, should we throw out the EOQ formula? Not at all. We need to apply a bit of common sense and creativity. Here are seven important lessons I have learned about the EOQ formula over the years:

1. The carrying rate should be used as a gas pedal. It is a variable that you adjust to control the total lot size inventory. On average, half of the lot size will be in inventory.

Estimate the total amount of lot size inventory you want for a group of items, add up the EOQ values for these items and divide the total by 2. If this is more than the total that you want, increase the carrying rate to drive the aggregate lot size inventory down to your goal.

2. Once you have calculated the right carrying rate to drive your lot size inventory, calculate the number of setups or purchase orders you will create. Make sure this is reasonable. Some people will actually use the carrying rate to drive to a targeted number of setups rather than an inventory level. This is common when setup costs are significant.

3. Large changes in lot size result in small changes in cost. If you look at the graph you will see it is very flat on both sides of the EOQ. Larger or smaller lots will result in similar total costs. The EOQ gets you in the zone, but the zone is pretty wide. Don't worry about being too precise.

4. Err on the low side. It is much better to pay a bit more to order another lot than it is to dump obsolete inventory. My fondue box taught me this lesson the hard way.

5. Setup times can be reduced. Years ago, we put all of our focus on improving run rates, ignoring setup time. If you have not worked on setup time reduction do it now. Simple improvements can lead to drastic setup time reductions. The result is lower lot size inventory, shorter runs, increased flexibility and better service. Nothing bad happens when you reduce setup times.

6. Use future demand to calculate lot sizes. With today's tools it is possible to calculate future requirements. Use these future requirements instead of historical usage to calculate the EOQ.

7. Beware of lot sizes greater than one month's usage. This is a "gut" check. There are some good reasons for lots bigger than one month, but make sure they apply before you let some computer system blindly drive your lot size inventory up. Ask these questions: Is the usage reasonable? Is the setup cost right? Can it be reduced? Is the carrying cost set too low? However, if you are pickling cucumbers, you will probably run your total year's harvest in one lot.

Bottom line: the EOQ provides valuable insight into lot size planning. Use it correctly, apply some common sense and you will get control of your lot size inventory.

Lot size inventory is muscle inventory. Give it a good work out and make it lean and mean.



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Project Matters: Part 1 S&OP in the Project Environment

by Doug Dedman

For 2 years I have written about S&OP in product sales environments. This is the S&OP home turf, where it has always been most used and most useful. But what if you sell projects rather than parts? How can you use S&OP in a project based business, and how will it help you to plan your resources?

The goal of S&OP in a project environment is the same as that in a product environment. Matching demand and supply.

The challenge is that predicting demand in the project environment is more difficult than in a product environment. And determining our supply requirements and constraints just adds to this difficulty. There are three reasons for this:

1. **Statistical forecasts don't work.** In most product environments we can use the past as a predictor of the future. Starting with past performance we can adjust for demand seasonality and economic conditions, which gives us the starting point of our forecast. But in the project environment this doesn't work. Typically there are much fewer transactions in the project environment, and this makes statistics less reliable. Each project represents a "lump" of demand, and usually we don't know when the project will be won or even when it needs to be delivered.
2. **Each project is unique.** This is a challenge for two reasons. First, delivery lead times are variable. In the product environment you have standard lead-times to the market place that may be dictated by competition or other factors. If we can forecast our orders, we can also forecast the delivery (which is important for production). And second, each project is unique. By definition a project is a "temporary endeavor, having a defined beginning and end, constrained by date or funding". Unique delivery characteristics, supply constraints, and even revenue streams are all hallmarks of a project.
3. **Demand for a single project may drive demand on multiple families.** A project may be complex. It may involve design engineering, production, service or installation engineering, and outside purchases. Each of these families is a constraint that must be solved if we are to deliver future projects.

Improving the Visibility of Demand

So now that we understand the challenges, what are the benefits of using S&OP in the project environment? First, let's talk about what we are trying to accomplish. The goal of S&OP is to match demand to supply. And to do this we need to improve the visibility of future demand. But what does this mean?

A project sale or prospect will move through several phases before it is "won" and the supply side of the organization can begin working. As the project moves through these phases, the number of sub-projects that are also worked on as part of the initial project will decrease. Quite simply, we need to start with a lot of prospects to end up with a few projects.

Unlike a "product sale" situation, i.e. a car, laptop, compressor, or coffee, the sales cycle goes through a longer process or more phases.

Because of the longer phases (prospect, then qualified prospect, etc.) getting visibility on the demand can happen during these phases.

This is best shown as a funnel, where prospects become qualified, then actively pursued until they are won.



The Project Qualification Funnel

Characteristics of Project Demand

During the prospect phase, there may be a customer situation that we are aware of, but not yet clear as to what the need is or what the deliverable will look like. This prospect moves down the funnel to become qualified.

The definition of what makes a qualified project will vary for each company, however, it typically means they have a need and the money to fill that need. For example, you may have done a preliminary quote to the prospect to qualify it.

After this, the opportunity will become an active pursuit. During this phase, engineers may be involved to develop detailed specifications, delivery and terms are negotiated, and the project is more clearly defined. This may happen while the customer is going through a detailed RFP (Request for Proposal) process.

Finally the project is won, and we can begin the execution phase.

The interesting challenge is that the involvement of the organization in a project is the inverse to the funnel.

At the top of the funnel the involvement may be limited to the sales organization. As we move down the funnel the involvement increases to include other areas of the organization such as engineering, finance, production and supply chain. In the project environment, the S&OP process is largely about communicating future demand early, before these areas are necessarily involved in the actual projects.

The following Pert chart shows the objective of moving the point of future project visibility early in the project life cycle as well as

across the functional areas of the organization.

The goal should be to move visibility far enough up the cycle to allow you to strategically plan resources.

If one of your constraints is critical components from a global supplier with a lead-time of 16 weeks, ideally you have visibility of a project that far out. So if it takes two months for a customer to move from the prospect phase to making a decision to start the project, and a typical project takes 2 months to deliver, you would want visibility out to the prospect phase.

If the project delivery phase is typically longer, you may not need visibility until part way through the pursuit phase. For human resource constraints, such as engineering resources, the lead-time to change the level of resources available is much longer. Increasing or decreasing the level of engineer support required to deliver potential future projects takes more time.

Improving Project Resource Visibility

Moving visibility to the top of the funnel for future projects will help with these decisions, but how do we do this? Not a simple answer.

I'm going to focus on just a few of the key items that are unique to making S&OP work in the project environment. This is by no means an exhaustive list, but it will get you started.

1. **Get sales and delivery on the same presentation.**
2. **Align probability to discount future projects.**
3. **Include both bookings and delivery for future projects.**
4. **Review key future projects in the S&OP process.**
5. **Use a project bill of material to break a single project into multiple families.**

The details of these items will be explained in next month's article, along with a discussion about demand flow and how to track it in a project.

Project planning is always about improvement, and that can take on many forms. Improved resource planning, improved sales management, improved cross-functional communications and trust—these are all areas that S&OP can improve in organizations.

In the end it's really about giving top level management a good handle on the business, by presenting a view of the future that allows the balancing of demand and supply.

Next month, I'll explain how we do this.



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