SCC Inventory Consulting, LLC

White Paper

Manufacturing Lot Sizing – Lean vs. EOQ

A Win-Win Approach

Steve Cimorelli, CFPIM **March 2007**

Introduction

In the debate over manufacturing lot sizing there are two general camps. “Lean Manufacturing” proponents push for lot sizes of one, or at least setup reductions in line with SMED (Single Minute Exchange of Die; i.e., setups measured in single-digit minutes) with the corresponding small lot sizes SMED allows. Those with direct manufacturing/operations responsibility look to minimize total costs by producing to an economic run quantity, arguing that this approach also maximizes capacity.

Both sides are correct. Manufacturing must run efficiently, taking into consideration the realities of ***current state*** setup times. This is especially true in capacity-constrained environments where reducing lot sizes without reducing setup times consumes more capacity by requiring more frequent setups. The disconnect between these two camps occurs when current setup times are assumed to be fixed. Lean efforts such as Kaizen events can be focused on setup reduction, moving the operation over time in the direction of Lean. As setups are reduced, corresponding lot size reductions can be immediately implemented, capturing the benefits in speed, agility and inventory reduction. This should be seen as a cyclical process. Each incremental reduction in setup leads to the next reduction in lot size until the business goal has been attained.

Since the perfect future-state will not be attained overnight, it is incumbent on both sides to work in concert, moving the manufacturing process in the direction of Lean, while always maximizing current-state capacity and minimizing total cost.

Background

A total cost approach, which is the basis for the traditional economic order quantity (EOQ), can provide a target range for establishing current lot sizes. Lean advocates argue strenuously against the EOQ, and have valid arguments. They rightly state, for example, that the EOQ understates the true cost of carrying inventory, and that costs such as obsolescence, handling, damage, floor space, insurance, etc. are not considered. This objection can be easily overcome by increasing the carrying cost rate from a company’s standard value (typically in the 10% to 12% range) to a value which reflects the missing costs; say 20% or even 25%. Another argument is that the underlying cost curves are not linear, as assumed by the EOQ formula, but are more like step functions. Again, this argument can be overcome by recognizing that the true economic lot size may not be the precise EOQ value, but is something in a plus/minus range of that value. A quick glance at the Total Cost Curve (Figure 1) shows that the EOQ exists in a range where the curve is relatively flat. Therefore any lot size in the vicinity of the EOQ achieves the objective of minimizing total costs. This allows the actual lot size to be rounded to a container quantity, or some other value that "makes sense" based upon the manufacturing process, material usage constraints, shift scheduling issues, etc.

In each example below, "A" represents Annual Usage, "S" is the setup cost, "C" is the unit cost per part and "I" is the inventory carrying cost expressed as an annual percentage rate.

Example:

A =	10000
S =	$ 50
C =	$ 100
I =	11%
EOQ =	302

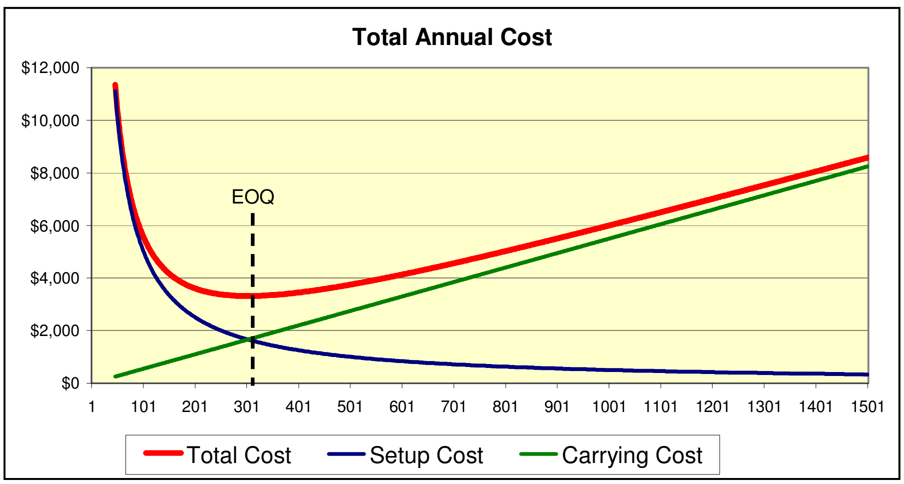

Figure 1

The goal is to constantly move in the direction of Lean, giving a bias towards rounding the EOQ *down*. Management's role is to encourage, incentivize, or even direct, this bias.

In the example above, notice that the total cost is minimized within a range running from approximately 200 to 500 pieces. The EOQ of 302 pieces can be rounded anywhere within this range. Note that this example uses a carrying cost of 11%. If that value is increased to 20%, to better capture the full costs of inventory, the EOQ shifts to a lower value of 224 pieces, as shown in Figure 2; i.e., it has moved in the direction of Lean.

Example:

A =	10000
S =	$ 50
C =	$ 100
I =	20%
EOQ =	224

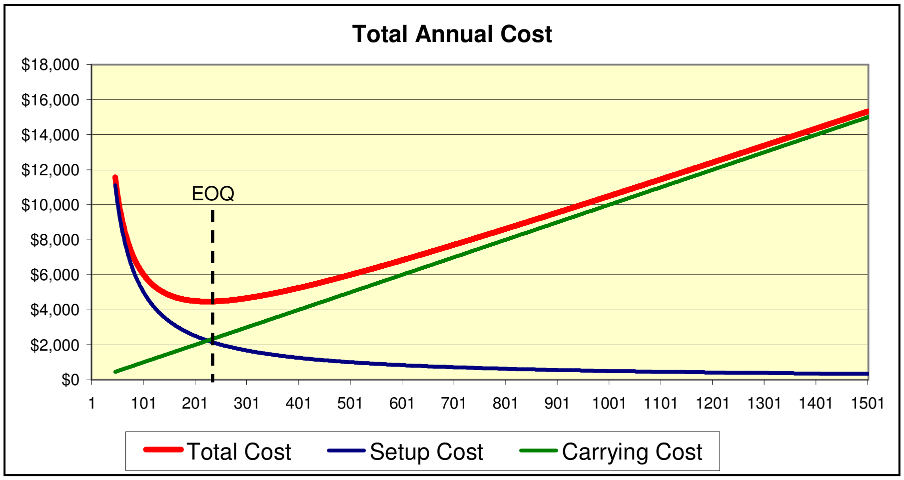

Figure 2

Recommendation

A compromise position between the two camps can be as follows.

1. Inflate the company-standard carrying cost to consider the full costs of inventory.
2. Establish current lot sizes near the EOQ, with a bias to round down towards the left-most edge of the flat portion of the Total Cost Curve.
3. Work aggressively to reduce setup times.
4. Follow each setup reduction with a review and recalculation of lot sizes. Reset lot sizes to capture the incremental benefit of each setup improvement.

Continuing with the above example, if setup is reduced by 50%, the impact can be seen in Figure 3. Again, the EOQ has moved lower, to a new value of 158 pieces, continuing the progression in a Lean direction. The Total Cost curve indicates that a lot size as low as 100 would still be reasonable.

Example:

A =	10000
S =	$ 25
C =	$ 100
I =	20%
EOQ =	158

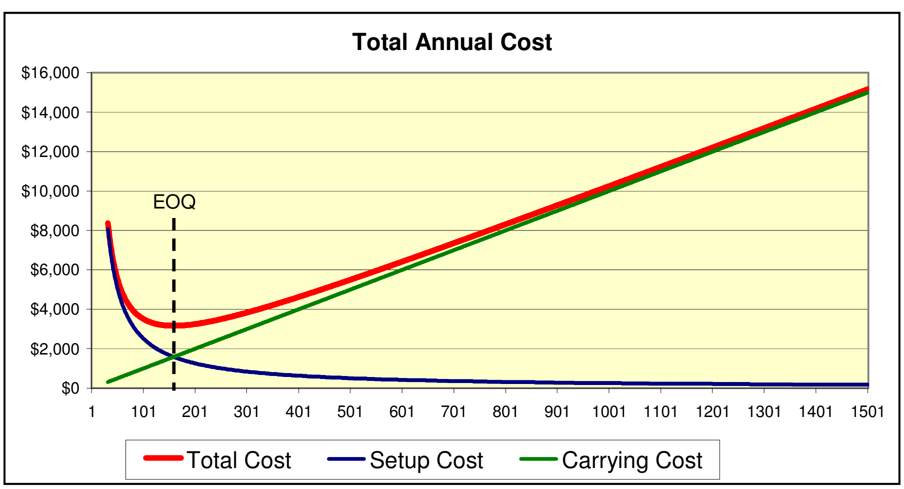

Figure 3

Setup Reduction

One approach to setup reduction is to provide a setup target cost, providing a goal for a setup reduction team, or kaizen team, to achieve. Let's say, for example, that a decision has been made to level-load production of a particular product, and that the desired standard lot size (target EOQ) is to be 50 pieces.

The EOQ formula can be restated to solve for Setup Cost as follows:

EOQ = Square Root [(2 x A x S) / (I x C)]

Therefore, S = (EOQ^2 x I x C) / (2 x A)

Applying this formula with a desired EOQ value of 50, results in a target setup cost of $2.50.

S = (50^2 x 20% x $100) / (2 x 10,000) = $2.50

If the hourly rate for setup is $20, this would equate to a setup target time of 7.5 minutes. Providing such a target can focus everyone's efforts on a stretch goal, versus a more arbitrary objective such as "cut setups in half" or "achieve SMED".

Conclusions

Both sides in this debate have valid arguments; neither is right or wrong. A win-win compromise is possible if all parties work together to reduce setup times, translate each setup reduction into a reduced lot size, and recognize the legitimate business need to make near-term production lot sizing decisions based upon *current realities.* Lean is the desired future state. Getting there is a journey, not a one-time event. The process described above can provide a roadmap for bridging the gaps along the way.

Author's note (April 2011): A reader discovered a minor error on page 4. The original text, reading "desired weekly production is to be 50 pieces", has been changed to "the desired standard lot size (target EOQ) is to be 50 pieces".

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