MANAGE YOUR TRAPPED CAPACITY

or find yourself jousting windmills

The modern manufacturer is struggling to become 'Demand Driven' and 'Lean' at the same time and they are coming into immediate contact with the complexities and variability in their product portfolio. Traditionally manufacturing organizations ran production cycles that lasted multiple weeks and S&OP organizations focused on balancing inventory (safety stock) against service level. These long cycles effectively absorbed the complexity and variability in the system. Capacity was considered a fixed asset to be depleted on each cycle. As organizations migrate to being lean and demand driven, the balancing act was no longer between safety stock and service level. Capacity loading—the degree to which a manufacturing asset is committed to run—becomes an important weight on the balance. The concept of capacity loading becomes either an asset or a liability to an organization depending on how it is used.

I wish to be lean, I wish to be demand driven, I think I have sufficient capacity, why am I always behind?

In the annual budgeting process of most companies, plants and manufacturing lines are given target rates that are based on estimated average capacity—if a line can average 100,000 cases in a week, it is assumed to be able to bear a schedule of 5.2MM cases in a year. Demand planners often accept these plans but find themselves in binds during the execution of the plan. Often these binds represent indiscriminate shortages and an inability to produce what is needed quickly.

Effective capacity is often considered the maximum run rate of a chokepoint discounted for reliability, unscheduled down time and first run yield. However, there is another correction on top of this. For most of the known world, demand is variable and capacity is limited. The usual catch all for absorbing variability in demand, forecast error, and supply is safety stock.

So I calculated safety stock based on my forecast error and schedule adherence, why do I still get in emergencies?

The answer is that safety stock needs to consider more than forecast error and supply variation; it needs to consider effective capacity loading. Most safety stock corrects for errors in the quantity you expected to sell (forecast error) and the quantity you expected to have on hand (schedule adherence). The assumption in this calculation is that you can replenish what is consumed each period.

The replenishment hypothesis does not hold if a manufacturing line is so loaded that a single demand spike—even a forecasted demand spike—cannot be replenished within one production cycle. Planning departments often get caught in a descending spiral by shifting schedules around and breaking production run strategies in an effort to correct one single SKU's shortage. This sets off a ripple effect to every other SKU manufactured on the line. Schedule changes, unanticipated changeovers, and general confusion caused by broken production run strategies, do two counterproductive things:

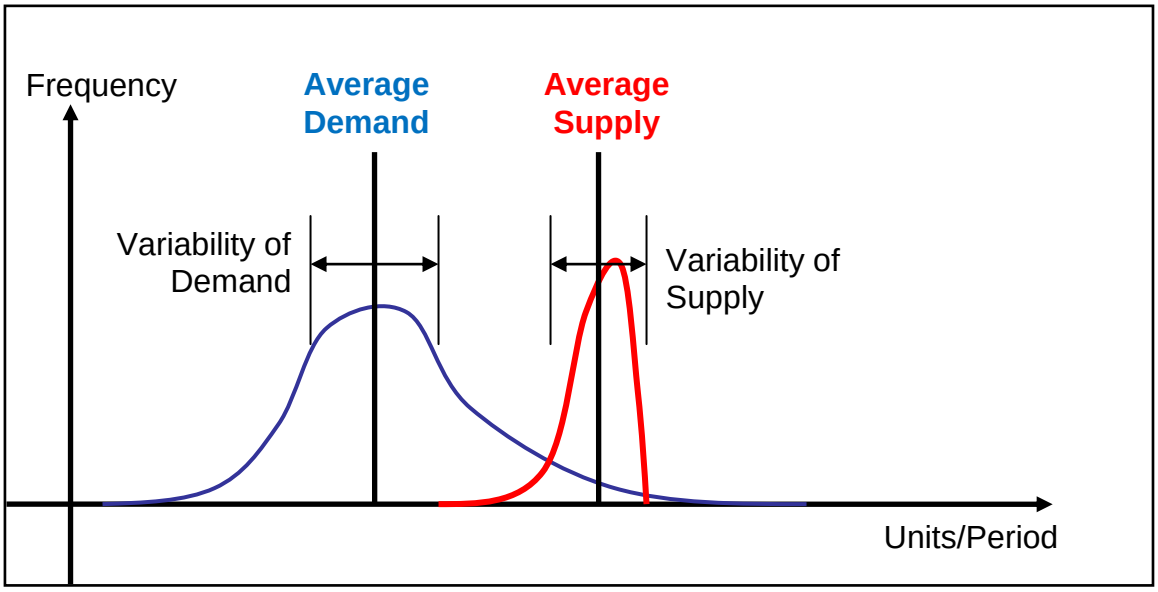
1. They decrease the effective capacity of a manufacturing line just when output is required most.
2. They upset the balance and harmony of a well planned production run strategy—shifting the symptom away from the ailment

If I can't stop demand spikes, how do I avoid these emergencies?

Essentially, demand variation is optimally absorbed by a combination of safety stock and surplus capacity. Relying only on safety stock and a heroic operations staff is not sufficient or economical. This is the central tenant of this article.

Figure 1 shows a manufacturing line that should have a wealth of capacity with the average supply exceeding the average demand. Given the variances of both supply and demand, there are periods where demand exceeds supply. However, at the surface, it can make more than it sells by the end of the year. That satisfies the accountants, but not the customers.

Figure 1—Supply and Demand Histograms

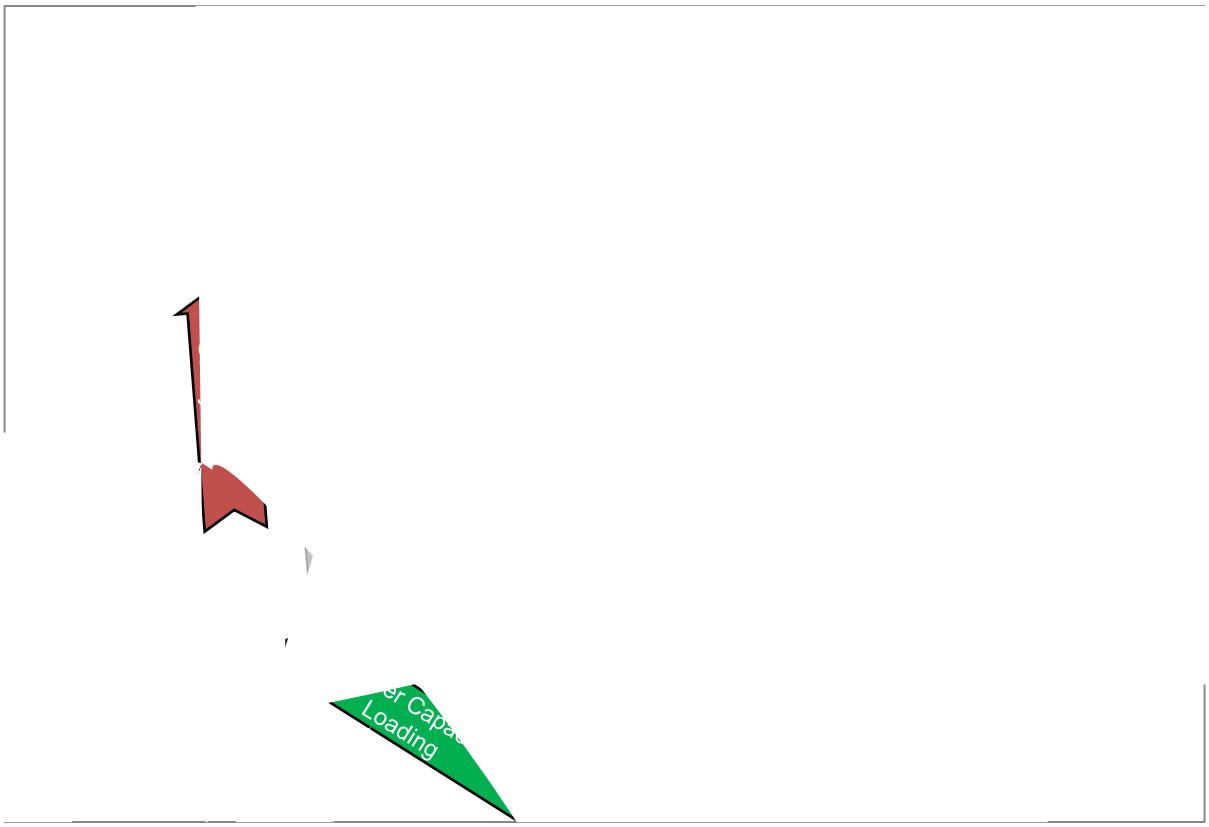


Any given peak in demand might exceed what can be produced in that given period. The more variable the system and the closer average demand is to supply means that demand will be shorted in increased frequency and severity. These shorts persist into subsequent periods and shift from SKU to SKU as production run strategies destabilize and schedules are overridden.

Figure 2 shows the relationship between demand variation, loading capacity, and safety stocks for a given schedule adherence. In fact, forecast error could be zero as it is in this graph (the perfect forecast hypothesis) and there could still be "Operational Chaos." "Operational Chaos" means you

are operating in a region where the day to day results of operations, output vs. demand, are so variable; you cannot predict how your system will react. Put another way, it would be difficult to properly calculate a safety stock to effectively match the potential range of need—you find yourself bouncing between random periods of surplus and shortage. No one can run lean or to demand while in the "Operational Chaos" realm of the capacity cube.

Figure 2—Capacity Cube (Forecast Error=0, Supply Variability=10%)



Source: SCTW Research

You can see that any line loaded below the dotted red line has minimal safety stock requirement. However, above the red line, the safety stock requirements become exponential. As a rule of thumb, you can only load a manufacturing line up to demand less one standard deviation of demand variation, after that, you enter an area that becomes rapidly unstable. This premium on capacity is often called "Captured Capacity" because the variability of the system has effectively captured a portion of the capacity to be used just to be flexible to demand. Yes enough safety stock can cover this (maybe a half year's worth—how big is your warehouse?) but will not be palatable to any company interested in running lean.

But the risk here is clearly shown—only a system that has 100% supply and planning reliability, perfect forecast, and 0% demand variability should be loaded to 100% of its effective capacity. Since most systems run at about 80% schedule adherence and over 20% demand variation, it is not out of the question that some manufacturing lines should only be loaded to 70 to 90%. And this figure is unpalatable to most executives unless properly explained and quantified. But the good news is that this tells people why they are struggling against persistent stock outs. And it provides a quantitative way to measure "Captured Capacity" and determine the degree to which they can be controlled.

Trapped capacity ThresholdRegionof Operational Chaos

So my demand is variable and I am capacity limited, what do I do?

First, no amount of "executive encouragement" will allow an organization to break the laws of physics and probability. You either take the uneconomical route of buffering yourself with lots of capacity and safety stock or you get focused and:

First, study your key variables:

- Portfolio Complexity—how much variability are the C and D SKUs passing into the system and do they really make money?
- Demand Variation—how much does the demand vary over the planning period?
- Available Capacity—how fast does a manufacturing line effectively run on average and how much time is available on that line?
- Supply Variation—how controlled is the production environment and how disciplined is the S&OP organization?

Second, calculate the max economic loading on a given manufacturing line and do not exceed it.

Third, set a continuous improvement in plan to increase this loading factor and recapture capacity. Once your manufacturing lines are broken down by these numbers, it is a matter of prioritizing projects to reduce the impact of these figures. The quick solutions can include:

- Effectively schedule products that can be sustained by a given manufacturing line→leaves time available to meet surges in demand but decreases total output
- Increase available capacity by opening up more time on the manufacturing line→quick, easy and costly
- Decrease demand variation by increasing production cycles→requires a decrease in changeover time and can be counter to lean manufacturing
- Decrease demand variation by changing consumer and trade promotions→eliminate promotions that increase variation without increasing profitability
- Look at SKU demand patterns and group SKUs that cancel out their respective demand variation→often times there are SKUs that replace one another and if they can be scheduled on the same manufacturing line than their net demand is smoothed.
- Drive unprofitable complexity out of the system

Long term solutions can include:

- Capital projects that bring capacity to the correct level to meet a products environment
- Changeover reduction plans
- Demand Shaping initiatives—often these can be very simple and have very limited impact on sales and marketing

Any of these and an unlimited set of others that increase the top line production, decrease demand variation, or improve schedule adherence will directly improve the company's exposure to service level failure or conversely overloading their balance sheets with inventory.

What does it all mean if I wish to be Demand Driven?

Demand Driven means getting the supply chain to operate closer and closer to demand itself. This puts increased strain on the balance between capacity, service level, and inventory. This balance is often not properly characterized or understood. They are usually tracked as three separate KPIs when in fact they are one. In frustration, executives resort to fiats: declaring production quotas, service level targets, and safety stock ceilings without calculating their interrelationship. The result—the planning and execution departments are pushed to constantly struggle an environment that is hostile to their goals. Goals become tainted by the organizations inability to meet them. And inevitably, the culture of firefighting takes root.

The path to "demand driven" success and recovering "captured capacity" is the same:

- Right size your complexity so that you are only addressing variability and costs that drive profitability
- Characterize your production environment and demand environment in quantitative terms
- Set S&OP goals that reflect this environment. Fundamental to this is scheduling only to a capacity that can sustain service levels
- Effect change by engaging in projects that move the underlying variables of the production environment
- Look for effective ways to shape the inbound demand and economically flex the capacity of the production environment

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