Roving bottlenecks

There is an ongoing ebb and flow in production. More often than not, there is some turbulence in that flow – the degree can vary over time. Whether one is in production, sales, or any other department, people in industry are all familiar with such ongoing challenges and have developed various coping mechanisms.

By Stephen Cherlet

In many factories, there are resources, known as bottlenecks, which throttle output. A bottleneck is simply a resource that is overloaded at a point in time. The resource can be people, equipment, skills or a combination. Many of these bottlenecks are relatively stable or consistent in their presence and impact. Companies are typically able to identify one or more key bottlenecks and work on trying to solve the underlying issues using some well-known techniques.

So, why should companies be concerned with bottlenecks? The key impact of a bottleneck is its restriction on throughput and therefore revenue. Simply put, constrained resources constrain the top line. The result is that an hour lost on a constraint resource is an hour lost though the entire system, not just that resource [1]. Therefore, organizations should be focused on continuous improvement as a way to increase output (revenue), usually with the outcome of cost savings as well.

Problem solving

A good starting point is to follow the key tenets of the Theory of Constraints [2]. Once the bottleneck is identified, companies must use the resource to its fullest. Then management should subordinate all other resources to the constraint resource. In other words, don't produce any item more than the bottleneck's ability to process them. There is no use producing 2 items upstream of the bottleneck if the constrained resource can only process 1 in the same time span. This can mean implementing appropriate management policies to restrict lot sizes on non-bottleneck resources even if it means leaving that work center idle.

The next step is to elevate the capacity of the bottleneck. Beyond adding people or equipment, there are several other problem-solving approaches, depending on the nature of the resource and the source of the problem. To increase throughput, or flow, we consider SMED (Single Minute Exchange of Die), Kaizen, and TPM (Total Productive Maintenance), among others. If process yield is implicated in the throughput limitations, then a Six Sigma process improvement approach using a DMAIC (Define-Measure-Analyze-Improve-Control) approach or DOE (Design of Experiments) is applicable.

Once one bottleneck resource has been improved, a different resource will become the constraint and the cycle must be repeated. The new bottleneck is usually easily identified in advance. However, despite our best efforts and intentions, new bottlenecks arise unexpectedly. They might pop up in areas that had previously been improved or that had never been a source of significant constraint. Then the bottleneck can disappear and a new one appears somewhere else. What's happening? Welcome to the roving bottleneck!

Change in product mix

In cases where management policies and process yield/variation have been addressed, as above, the main culprit behind roving bottlenecks is a change in product mix [3]. General changes in market demand are typically visible well in advance for firms with a well-honed SOP (Sales and Operations Planning) process, combined with a proper review horizon and frequency [4]. With this advance notice, the supply chain team would prepare appropriate remediation plans. They

About the Author

Stephen Cherlet is a senior management professional with 35+ years of experience across engineering, manufacturing, quality assurance, materiel, information and production technology, project management, and lean transformation. Industry experience includes aerospace, defense, and industrial products. His last role was COO at Velan Inc (TSE:VLN) responsible for global operations, supply chain, and information technology. In 2016, Stephen joined FarStar SAC Consulting to help companies improve their business systems, operations, and supply chains. To find out more https://www.linkedin.com/in/stephencherlet/ He can be reached at stephen@farstarconsulting.com.

would be looking into inventory, lead times, and resources to cope in time to manage the change.

In project-oriented operations, the problem is essentially also product mix, but the problems often arrive with less warning and more dramatic impact on resources. So, what are some of the specific causes of the roving bottleneck in project business?

Thud

First of all, supply chain timing. Project orders tend to arrive as a "thud", figuratively speaking. A large order arrives as a single event, starting off a chain reaction. The organization gears up to respond, and many things happen at the same time, including procurement. Planners rush to get requisitions approved and sent to Purchasing. Buyers spring into action placing orders. A number of external processes have similar lead times, setting up a potential for lots of materials to arrive at the factory all at once. Sometimes, to save freight costs, companies actually plan for large influxes of material by consolidating freight. This onslaught of material is often expedited onto the factory floor all at the same time and the bottlenecks begin to appear.

Overburdened

Then there is customer scheduling. Customers generally request delivery to suit the start of their schedules (construction or outage, for example). As a result, they often provide a single date for all the line items on their purchase order. In fact, most ERP (Enterprise Resource Planning) systems promote this by automatically copying the due date of the purchase order header to every line item. It's easier for Buyers to leave this alone rather than calculating individual required dates for every line item on an order with many line items. In a backward planning system, which covers most ERP systems and their planning engines, this means a lot of (tail end) activities are going to be planned to take place at the same points in time or same tactical time horizon. This can lead to overburdened resources.

Contract requirements

Third, there is the nature of contract requirements. Over the normal course of business, there is a mixture of contract requirements that generally stays within certain boundary levels of intensity. A single contract, however, can include a lot of special requirements that results in abnormally high work levels. For example, contracts might impose high levels of x-ray (radiography), NDT (non-destructive testing) like dye penetrant and magnetic particle inspection, or cryogenic testing. Government orders might involve a lot of first article inspection or pre-assembly inspection. Some customers insist on witnessing inspection or test operations (which they like to group together to save travel costs, but which can delay production and also reduce throughput). Nuclear orders can involve all the foregoing requirements. These specific, contractual requirements can cause workloads in specific areas or departments to reach higher levels than normal. Sometimes these levels overlap, due to the earlier points on scheduling, causing real peaks – like superimposed sine waves. These types of resource impacts are generally not visible at the level of the SOP. Their impacts are usually visible, at best, only once the job is in-house and contract-specific work order routings are released. At this point the scheduling/planning engine of the business system can flag the problems – but now organizations are in reaction mode.

Product mix

Finally, there is the product mix (or lack of mix) itself. In the baseline flow of work in a typical OEM (original equipment manufacturer) there is a certain mix of product. Project orders can dramatically shift that mix depending on the nature of the job. For example, there might be a large portion of the order all for one product line. In some cases, the order may be all for one range of sizes. Some orders can be for valves that are all actuated. This can cause overloads on specific pieces of equipment, departments (like assembly), or suppliers (ex. for mounting accessories).

Having listed all the causes, what can be done to mitigate the impact of the various issues associated with project orders?

In case of new designs, supply chain and operations teams should work with engineering to backward plan from customer delivery through the entire production process and supplier lead times to calculate dates when new/revised drawings are needed. Focus on the longest lead-time materials like castings, forgings, and actuators. Remember, engineering, too, can be a bottleneck. Once planning dates are established for the long lead items, then teams can focus on the shorter lead time items.

Communication with suppliers

Also check with your suppliers to (re) validate lead times. Their loading may have changed, resulting in different lead times today than when they quoted the project. This may apply to items that were not specifically quoted, but where Buyers used generic lead times – time to get real commitment dates. The production planning engine, manual or system-driven, needs accurate material arrival dates to calculate the internal schedules based on material constraints. Lead time validation is a case where technology, like a supplier collaboration portal [5], could provide some time savings and efficiency gains. Another factor might be that your own factory lead times for critical processes or equipment may have changed. Time to go and check, then update routing times or start/end dates. Look at key processes for open availability and sequence material to arrive on dates when they can be launched onto the shop floor into "open windows" of resource availability. Stagger the planned completion dates of shorter lead-time items to avoid conflicts near the delivery date.

Invest in training

It could also be helpful to develop a cross training program and create a documented matrix of key skills. In this way employees can be deployed when and where they are most needed. For example, testers are needed towards the end of the project schedule, but visual inspection and NDT may be needed up front or in the middle of the project – if people have multiple skills, then they can be deployed to suit the peak. Consider also machinists who can assemble and assemblers who can test, and vice-versa. Finally, keep communication lines open to the customer. A frank discussion could enable more of a spread in the delivery dates. As mentioned earlier, customers often issue contracts with a single delivery date for all line items. Consider negotiating staggered delivery start dates and end dates. Ask the customer for their need dates based on their construction/ outage schedule. They cannot use the full quantity of every line item at the same time. The customer can provide you with their needs based on criticality and timing. Alternatively, propose start dates and delivery rates, especially for line items with higher quantities. This approach will help you and your customer by reducing their total inventory on hand, and on the job site.

The above tips won't prevent, or eliminate, roving bottlenecks, but they should help ease the pain throughout the supply upstream and downstream from you. Hopefully, with improved delivery date adherence and customer satisfaction.

References

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