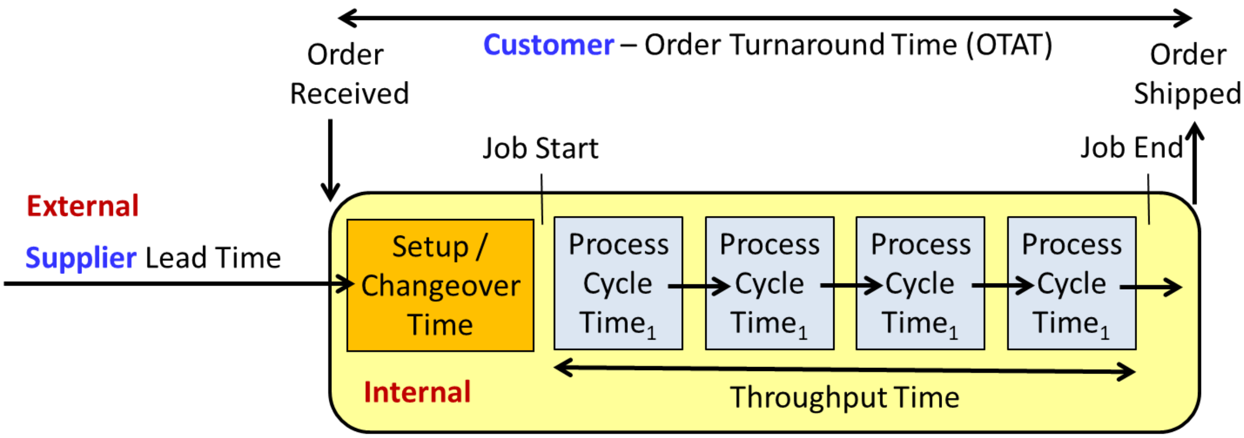
PROCESS REFLECTIONS

Understanding and Calculating Lead Time Efficiency for Discrete Manufacturing

In a prior process reflection, we discussed decomposing work activities a a sequential structure that tracks all time pathways which connect process events using terms that are logically distinct to clarify the operational situation and develop accountability for performance across the sequence of performance intervals. This was illustrated as follows:



Management cares about the efficiency in using time to perform productive work. Therefore, it is important to calculate Lead Time Efficiency (LTE). LTE describes how well standard Lead Time is operating and is based on collecting all orders received and tracking their progress as they travel across required work activities from receiving the order through shipping a final product. It includes preparation and administrative time, productive time, and some allowances that need to be included. Part of the LT calculation relates to office procedures like receiving the order, production planning, ordering production, and shipping. These actions must be included in preparation time and productive time (also called "net time" as it is the time that remains when preparation time and allocations have been subtracted from the total time (e.g., Order Turnaround Time (OTAT)). Preparation time should not include waiting time, verification (e.g., inspection or testing) time, or any material collation time (e.g., for kitting, picking, or routing). It is also subject to improvement so these activities should be included as processing time. The LT can be summarized in three steps: the receiving and processing order process, the production process, and the final inspection and shipping process.

Begin the calculation of LTE by starting with the Standard LT from a benchmark product which is of similar complexity that is already in production. It is only useful to calculate LTE if there is a sufficient production capacity so the manufacturing process is not constrained by any possible shortage in production equipment so that it is possible to produce parts in parallel and without an impact on current production demand. Standard LT should be calculated for the critical path of the current benchmark product. It should be calculated as an average of this benchmark as it proceeds from order receipt to shipment of the product. Note that this is similar to the use of

"Little's Law" as it is based on an enumerative or summary perspective of performance over time as it is calculated for average results.[1]

The components to be considered in calculation of standard time include net time, preparation time, and an allowance time ratio.

Standard Lead Time = (Net Time + Preparation Time) x (1 + Allowance Ratio)

where;

Net Time: the time that the productive systems are operating including all of the assembly work from staging material for production, turning on the production equipment, operating the process including in-process work inspection, machine work time up to the stoppage, material removal, and movement of produced goods to the next process step.

Preparation Time: the accumulation of all time prior to net productive time and it includes preparing of all production materials, die, jig and tools, carts, pallets, containers, drawings, workmanship standard; setting-up jigs and dies, as well as the clean-up of the equipment after production is completed.

Allowance Time Elements (4 types of allowance can be made):

- *Working allowance* (put oil or lubricant, correction of defect, care of jigs and tools, handling of left-over materials, shavings, and chips, changing the cutting devices, etc.).
- *Workplace allowance* (power failure, machine trouble and down, material waiting time, short meetings for share information (seiri-seiton), seisou, on-the-job training, etc.).
- *Physiological allowance* (drinking coffee or water, toilet breaks, rest breaks, etc.).
- *Fatigue allowance* (rest required when handling heavy articles or working in high heat).

However, reducing preparation time shall also be considered a goal of efficiency improvement, and allowance time needs to be minimized and standardized as a separate consideration from net time; thus, standard time reduces to net time since the other components are managed on the side.

So, is it possible to achieve an LTE index of 100%? This is not possible because preparation time and allowance time can never be zero. The allowance ratio ranges from 13% to 25% (depending on the type of industry and process the allowance time changes). Then Net Time and Allowance Time are normally inevitable (without any cases of workplace allowance such as power failure,

[1] Little's Law describes a formula by John D. Little that states the long-term average number of customers in what he called a "stationary system" (L) is equal to the long-term average effective customer (order) arrival rate (λ) as multiplied by the average time that a customer spends in in the end-to-end system (from order to completion) (W). This operates for summary data (stationary – in other words it is not arranged as a time series). The original article was: John D. C. Little (1961), "A Proof for the Queuing Formula: $L = \lambda W$," Operations Research, 9:3, pp. 383-387.

machine trouble, or any delayed material arrivals). Preparation Time should be targeted for reduction. Therefore, LTE can be targeted no higher than 80 to 87% as a reasonable target. For example, when the net efficiency is optimized then it would operate at 85% efficiency if the allowance ratio is 15% in total.

Therefore, well-managed production should plan human operations in production for 85% of the total available scheduled production time [note that this rule does not hold for a continual flow process such as chemical processing or petroleum industry].

Reflective Questions:

1. Taiichi Ohno said: "if there is stagnation, then problems lurk." Lead Time Efficiency is a way to examine how much inefficiency lies in an end-to-end productive system. What is the level of your own productive system's Lead Time Efficiency? Can you identify the areas where efficiency is lost? At what level of abstraction with respect to work process detail is this judgment made? When should you use this measurement system to make judgements about your need to improve?

2. Decomposing LTE into sub-process categories and analyzing tie in "process buckets" is a way to discover where improvements should be focused – this applies the methods of Exploratory Data Analysis (EDA) to find where change is necessary and pinpoint exactly how a process change needs to be concentrated as EDA links process performance to the performance efficiency of the process cycle times. How is LTE linked to indicators of process capability to identify special causes of variation that may be removed by either applying lean methods or by developing more consistency in process throughput? You identified where process efficiency is lost in the prior reflective question can you trace back the time loss or efficiency leakage to its source?

Lesson to be Learned:

Lead Time Efficiency (LTE) is a management indicator similar to Cost of Quality (COQ). This index does not describe exactly how much improvement is potentially possible or precisely where such improvement could occur. Instead, it creates frustration within management, so they no longer are willing to accept this inefficient state and it generates dissatisfaction to the level where management believes it is compulsory to concentrate on initiating an improvement.

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