

VSM Terms, Calculations & Units of Measure (UOM)

Available Working Time (AWT)	- The time a process is available to conduct work. - AWT excludes time when work isn't occurring such as time for breaks, meetings, lunch, preventative maintenance (PM), estimates of unplanned downtime, change overs, etc.	$\text{AWT} = \text{Shift duration} - (\text{breaks, meals, meetings, PM} \dots)$ UOM: year, month, day, hour, minutes, seconds...
Throughput (Tput) 	- The average number of good parts or transactions completed over a period of time. - Typically measured as average over at least several days.	$\text{Tput} = \frac{\# \text{ good items}}{\text{period of time}}$ UOM examples: parts per day, transactions per hour, etc.
Lead time (LT)	- The total elapsed time to produce one defect free product or transaction. - Alternative way to state it: the time difference between when a part or transaction enters and leaves a process.	<i>LT calculated using Little's Law</i> UOM: year, month, day, hour, minutes, seconds...
Customer Demand Rate (CDR) 	- The number of parts or transactions that the customer desires over a period of time (usually a day, week, or month). - For example, a purchase order quantity or a yearly forecast. - The CDR is needed in order to calculate Takt time (TT); broken down into the same units to be used for TT. For example, a yearly forecast broken down into a weekly or daily quantity.	$\text{CDR} = \# \text{ items required in a time period}$ UOM examples: 500 parts per month, forecast of 50 prototype designs per year, etc.
Takt time (TT) 	- The pace at which an operation should complete products or transactions in order to meet customer demand during the Available Working Time. - Available working time during a period divided by the number of products or transactions required during that same period.	$\text{TT} = \frac{\text{AWT}}{\text{CDR}}$ UOM example: time per item $\frac{\text{minutes/day}}{\text{parts/day}} = \frac{\text{minutes}}{\text{part}}$

VSM Terms, Calculations & Units of Measure (UOM), cont'd

Cycle time (CT) 	- The fastest repeatable time between part or transaction completions using the current processes and resources. - Shows what a process is capable of, typically measured through “clocking” the processing time and determining the fastest repeatable (sustainable) time. - Combines with AWT to determine capacity: if we know how much time we have, and how much time we need per part, we can figure out how many parts we can make during that time.	$CT = \frac{time}{item}$ UOM : time per item
Work In Progress (WIP)	- Includes items waiting to be worked on and items actively being worked on. - WIP includes all inventory in the production system, i.e., within the workflow scope.	$WIP = \# items$
Little's Law	- Formula for estimating Lead Time from WIP and either Throughput or Cycle time. - Typically, we are working with Averages although minimums and maximums may also be helpful. - UOM calculation example using Throughput (Tput): $\frac{\# WIP parts}{\# good parts} = \frac{hours}{hours}$ - UOM calculation example using Cycle time (CT): $\# WIP parts \times \frac{hours}{part} = hours$	$LT = \frac{WIP}{T_{put}}$ or $LT = WIP \times CT$ UOM: time
Process Cycle Efficiency (PCE)	- The percentage of time that WIP is being transformed by VA activities. In other words, the percentage of lead time that is value added. - No units since it's a ratio, usually reported as a percentage and it's understood the context is time.	$PCE = \frac{VA time}{LT}$

VSM Calculation Examples

Example of Takt Time & Cycle Time

Working time per day = 450 mins (7.5 hrs)

Avg. daily quantity required = 55 units

Avg. daily defect free quantity that we can produce = 48 units

$$\text{Takt time} = \frac{450 \text{ minutes}}{55 \text{ units}} = 8.2 \text{ mins}^*$$

$$\text{Cycle time} = \frac{450 \text{ minutes}}{48 \text{ units}} = 9.4 \text{ mins}^*$$

* technically, "minutes/unit" but it's typical to just state these terms in "time"

Example of Little's Law

Total average WIP for all steps of a process = 100 items

Cycle Time = 9.4 minutes/item

Avg. Lead Time = 100 items × 9.4 min./item = 940 minutes

or

940 min. × 1 hr/60 min = 15 hours, 40 minutes

Customer value adding (CVA)

- Activities that are required, from the customer's point of view, to provide the desired products and services
- What the customer is willing to pay for

Non-value adding (NVA)

- There exists a feasible future state in which the desired products and services can be provided without these activities

Business value adding (BVA)

- Activities that are not CVA, but cannot feasibly be eliminated under current constraints