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Case 2 – VSM case: assembly of printed circuit board.

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Takt Time

Takt time is the time a finished product needs to be completed in order to meet the customer demand. Thus, the takt time defines the frequency of our production system.

$$takt\ time = \frac{available\ working\ time}{customer\ demand}$$

We can see that the customer demand is at first place and determines the takt time.

Customer takt time :	Production takt time :
$\frac{27\,000 * 2 * 240}{11\,894} = 18{,}2\ min$	$18{,}2\ \text{min}\ x\ 14{,}8\% = 2{,}69\ min$

Why do we need to differentiate the customer takt time and production takt time in this case?

In this case, we know that the studied circuit board constitutes only 14,8% of the total production volume. Therefore, we can assume that the two shifts allocated to this prodcution are available at 14,8% and use the rest of their time by working on other products. Hence we will use the production takt time for the capacity analysis.

VSM

Cf. our Value Stream Mapping on our last page.

Reflect and comments

Process efficiency:

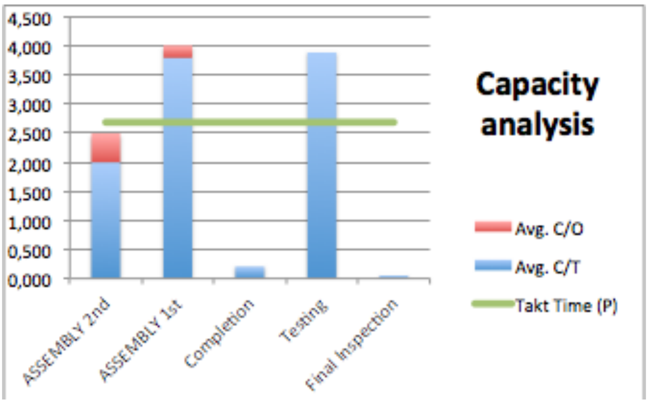
$$Peff = \frac{Total\ Process\ Time}{Total\ Lead\ Time} = \frac{42{,}8\ min}{14123{,}3\ min} = 0{,}3\ \%$$

The process efficiency is really low in our case. It means that only 0,3 % of our total lead time is adding value to the products. Therefore 99,7 % of the time is waste. One of the biggest impact is the inventory stock in the end of the process (on average 3 weeks).

Bottle necks and under- or overcapacity:

With the capacity analysis we can evaluate that the "Assembly 1st side" and "Testing" can not meet the needed production takt time (undercapacity) and display bottlenecks. This results in an insufficient supply of the total amount of products and the company can't produce 26169 expected units. Furthermore it can be assessed that the workload is really unbalanced. "Completion" and "Final Inspection" have more buffer time than they need (overcapacity), which decreases the resource utilization and is costly and inefficient.

$$Undercapacity\ (units) = \frac{Undercap.* Production(\frac{units}{a})}{avg.Cycle\ Time\ (Bottleneck)} = \frac{1{,}2\ min * 82671p/a}{3{,}89\ min} = 26169$$



Setup Times:

Regarding the setup time, we want to use the tool "SMED" in order to convert internal changeover time to outer changeover time. Therefore the high changeover time of 75 min and 32 min in the assemblies can be minimized.

Batch Sizes:

As we can see in the VSM drawing, there are several batch sizes for each operation. Indeed, the batch size varies from 1 in the testing process to 150 in the assembly process. The important batch size in the assembly process causes definitively bottleneck issues by creating a lot of WIP inventory. However, if we decrease the batch size of the assembly process, we will have capacity issues because of the changeover time.

$$Adjusted\ demand = \frac{Customer\ Demand}{Quality\ Rate} = \frac{11894}{74\%} = 16073$$

Quality rates:

The quality rate given after each process is respectively 93,6% - 93,6% - 92% - 92,3% - 99,4%. At the end of all the processes, we will have 0,936 x 0,936 x 0,920 x 0,923 x 0,994 = 0,74 so 74% of conformity. The quality rate needs to be improved or it influences the (adjusted demand) and therefore also the takt time, which is needed to achieve the total production output.

Process stability:

Here, a key point to study the stability is to check how many pieces are nonconformed to the specifications (which percentage it represents). Here we can say the percentages of the quality rates (seen in the previous part) are really too lower, which mean there are too many unconformities. There are today too many variations in the process. Table 1 displays that setup and cycle times are not in statistical control (outside 6σ) and therefore not stable.

	Min	Max	Mean	Sigma	3*Sigma	CL_up	CL_lower
Internal Setup2	15	175	75	49	147	222	26
Internal Setup1	9	104	32	26	78	110	6
CycleTime2	1,3	3,9	2	0,5	1,5	3,5	1,5
CycleTime1	1,5	5,3	3,8	0,8	2,4	6,2	3

Table 1: Process stability

Recommendations

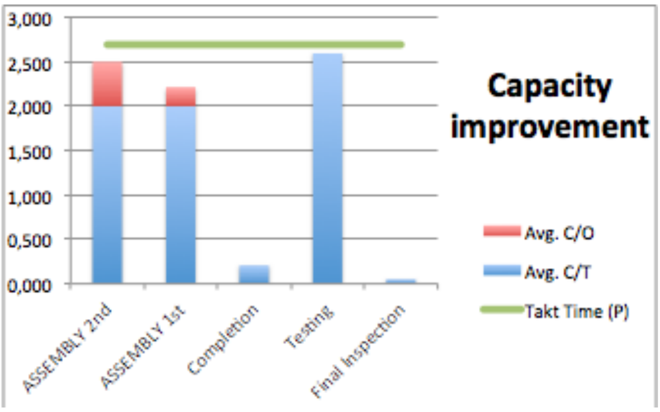
What recommendations would you give to the company?

The aim of the company is to fulfil the customer demand, so they have to **improve the process efficiency** and **level the capacity** in order to meet the production takt time.

Now, the process efficiency is only 0,3%; so it is necessary to increase it, which can be done by reducing the lead time:

- The main factor of waste is the FGI, as is of 3 weeks on average. So as these recommendations are for improving the way of production in the company and to level the demand meeting the takt time, the FGI inventory will not be needed, so it will be reduced to 1 day (900 min).
- In order to reduce the inventory waiting time between completion and testing, we will reduce the batch size of completion from 30 to 3 (it is not possible to reduce it to 1 because that will create a new bottleneck).
- We recommend decreasing the batch size in the assembly processes. Indeed, if the changeover time in this process has been minimized and the assembly 1st process has the same cycle time as assembly 2nd, we can assume that a batch size of 30 items will be better. It will allow eliminating the inventory between the assembly process and the completion process.

To levelling the capacity the firm has to eliminate the two bottlenecks that actually exists:
- In order to eliminate the bottleneck at "Assemble 1st side" we recommend to investigate the process steps in detail. Due to the fact that "The process steps are the same for the secondary and primary surface mounting", we compared those. The time of the process steps is nearly similar with the exception of the "Mounting"-steps, and especially "Mounting 3 & 4". If we are able to reduce the time for these process steps to the time of the "Assemble 2nd side", the bottleneck disappears.
- The second bottleneck is at the workstation "Testing". Currently two parallel machines are used to do the testing. If we increase the number of machines to three, we can already meet the production takt time.

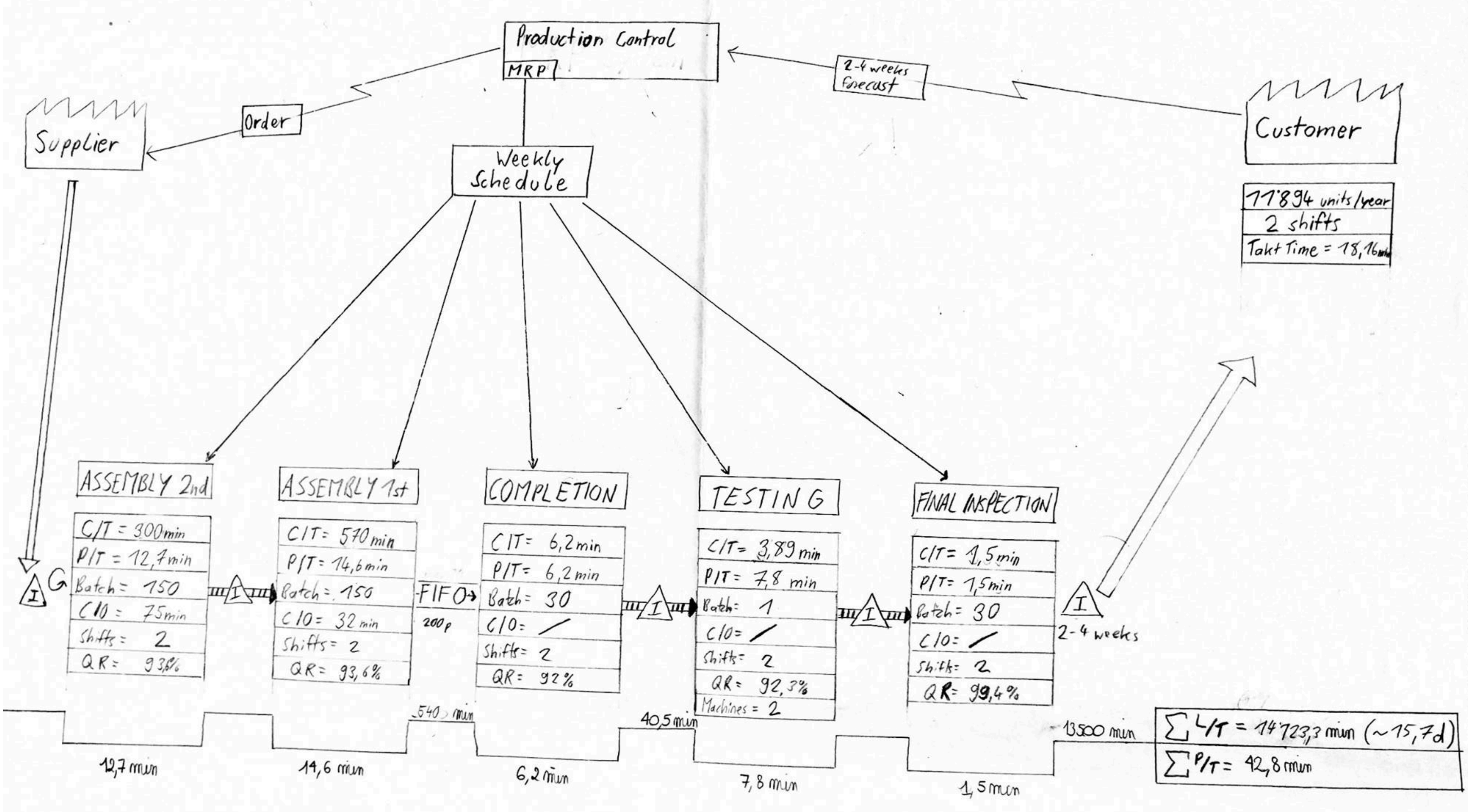


With all these recommendations, the process efficiency will be increased in 10%, as well as the company will be able to meet the customer demand.

Concerning the low quality rate, we recommend to investigate on the root causes that are responsible of the defect (except on the last process « Final inspection » which has a rate of 99,4%). For this we recommend to use tools like Pareto' chart or 5 why's method or Ichikawa diagram. Once causes are found out, the team in charge of the process needs to take corrective actions in order to solve the defect's cause, and after that, to standardize the new procedure. We encourage the use of PDCA tool to maintain the new practices. We also recommend to implement Jidoka method, by using for instance Poka yoke tool, in order to avoid producing value on nonconform product. All these actions will permit us to have a stable process.

<u>How can the company handle an increased customer demand?</u>

If the demand of the customer gets increased, the customer takt time is going to be reduced (because is indirectly proportional), and thus, the production takt time will be also reduced. So the first bottleneck that the company will find will be again the testing process, so it will be necessary add, at least, one more line in parallel. Furthermore, there will be another two bottlenecks, situated in both assembly process, that will have the same solution: add one more line of parallel production in each.
If the product which demands has been increased is one that provides high incomes to the company, they can decide to dedicate more percentage of their production to it, so the production takt time, will not be reduced as the customer takt time does, and in that way, the company will have more margin to act.


Production Control
MRP
2-4 weeks Forecast
Order
Supplier
Customer
Weekly Schedule
11'894 units/year
2 shifts
Takt Time = 18,16min
ASSEMBLY 2nd
C/T = 300min
P/T = 12,7min
Batch = 150
C/O = 75min
Shifts = 2
QR = 93,6%
ASSEMBLY 1st
C/T = 570 min
P/T = 14,6 min
Batch = 150
C/O = 32 min
Shifts = 2
QR = 93,6%
FIFO
200p
COMPLETION
C/T = 6,2 min
P/T = 6,2 min
Batch = 30
C/O = /
Shifts = 2
QR = 92%
TESTING
C/T = 3,89 min
P/T = 7,8 min
Batch = 1
C/O = /
Shifts = 2
QR = 92,3%
Machines = 2
FINAL INSPECTION
C/T = 1,5 min
P/T = 1,5 min
Batch = 30
C/O = /
Shifts = 2
QR = 99,4%
2-4 weeks
540 min
40,5 min
13500 min
12,7 min
14,6 min
6,2 min
7,8 min
1,5 min
∑ L/T = 14'723,3 min (~15,7d)
∑ P/T = 42,8 min