

A method to ensure IE Standards, Capacity Planning and Actual Measurement in perfect synchronization for right investment decision

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Abstract

As the semi-conductor business grows, the customer volume, varieties and complexity also grows accordingly. The maximum of what a factory is able to produce and commit to customers will be constrained by the factory bottleneck. It is highly sensitive for capacity calculation, investment decision and customer commits. Accurate machine performance measured using OEE (Overall Equipment Effectiveness) is important. In this project, we will discuss how we apply the OEE measurement at the one of our backend factories at Melaka, Malaysia in the molding area. Through the OEE reporting, the performance is not meeting the plan in the key elements of invalid data and speed loss. In order to address this gap, an effective method by using DMAIC problem solving methodology is required to classify the accuracy of each element and recommend the attention to the focus problem area. In this paper, OEE improvement systematics will be discussed and sharing of implemented results in the project with total of 510EuroK investment avoidance has been achieved.

Keywords

Overall Equipment Effectiveness, Process Performance, Time Deviation, Equipment Monitoring, Productivity

Introduction

As our business grows, OEE has become increasingly important for measuring actual molding machine performance versus target. Any deviation may have an impact on the customer deliveries and result incapacity fulfillment issues and poor investment decisions.

The challenge for the project is not merely on identifying the losses of machine performance but also to understand the machine utilization in capacity planning system used by planner, the plan database that industrial engineer used to maintain the plan uph after time study conducted, and the OEE report monitoring that is linked with throughput signal and configuration collection from the machine. These three important aspects helps equipment, industrial engineer and planner can focus on the real OEE losses with the accurate OEE, gap closure so that the team can make a right decision on investment avoidance.

The concept or principles should allow similar implementation at other critical process that requires certain the factory's attention.

System Development

This project is based mainly on the experience and benchmarking of industrial engineers, planners and management requirement to design the systematics.

System Requirement

- A. Capacity Planning system – a model which is capable of calculating the capacity using the number of machines in the factory, the plan OEE and the plan UPH with an assumed yield
- B. Plan database – a database where all the plan & assumptions are stored
- C. OEE report – a measurement of the actual performance and all the losses incurred by the machines
- D. Equipment Automatic Time-Study tool

Problem Statement

In capacity planning system, molding process is classified as the bottleneck process. The machine utilization > 100% which represents that the existing number of molding equipment in the factory cannot cope with the customer demand in coming 10 months. Immediate machine investment is required to fulfill the delivery commitment.

Table 1: Example of machine utilization table in capacity planning system table by different group based on 10 months' data

Operation	Group_Name	month 0	month 1	month 2	month 3	month 4	month 5	month 6	month 7	month 8	month 9	month 10
0000_Molding	XX	100%	510%	732%	206%	501%	544%	180%	1010%	780%	780%	604%
	YY	420%	708%	540%	760%	750%	680%	250%	450%	1058%	115%	150%
	XX	278%	360%	664%	204%	205%	1225%	705%	870%	694%	751%	240%

However, actual OEE report shows there is high losses in invalid data and process speed. This is not showing the same direction as the capacity planning system. (See Figure 2 for the OEE report by different classification for the Month 1 to 3). This triggered immediate team investigation.

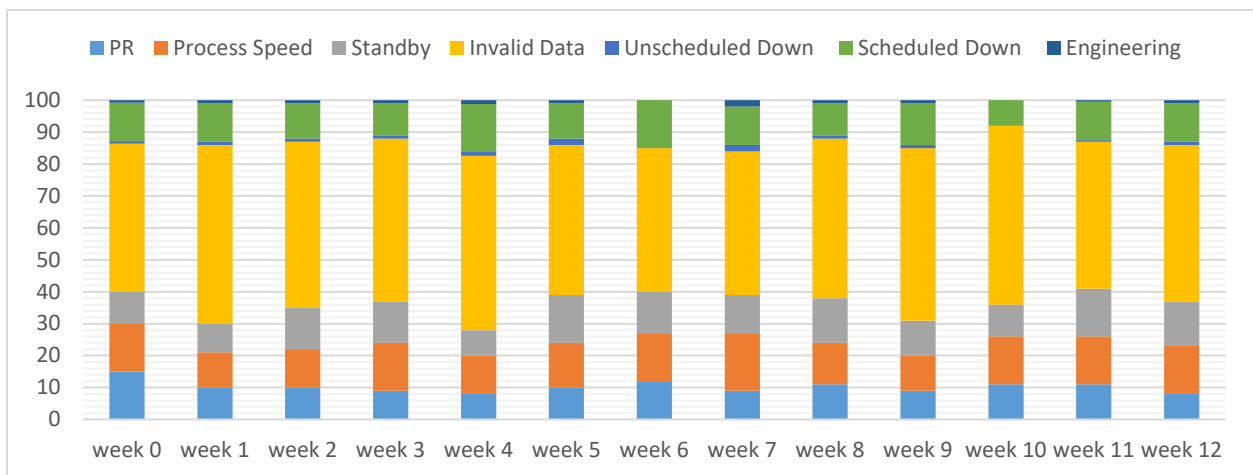


Figure 2: Example of OEE report by different classification bar graph based on 3months' data

Investigation

The Team decided to use DMAIC approach as the underlying working method.

In the Define stage, the team desire to get the flawless linkage between IE basic data and capacity planning system and to reflect the actual machine performance in OEE Report for addressing the correct issue with productivity project.

In the Measurement stage, a simple process mapping is used to identify the business process that needs to be improved. With the fishbone analysis, three input factors identified:

- i. machine signal setup,
- ii. Infineon OEE Reporting default setup and
- iii. deviation between plan UPH versus actual UPH

are listed as potential contributors to the data accuracy in capacity planning system, plan data system and OEE report. Data collection is required on each potential factor.

In the Analyze stage, each factor is tested:

1. Machine signal setup

Existing molding equipment is collecting signals from mold pressing to unloading station. The data will be sent to OEE reporting. Data integrity is poor as it is unable to reflect the actual equipment performance and not able to identify the real losses. When an equipment is stopped unexpectedly, a certain delay factor is allowed before the alarm triggered for operator attention. However, the equipment is actually idling. A comparison table is illustrated to show the golden setup and existing machine (see table 2 on the golden setup versus existing machine setup)

Table 2: Example of golden setup versus existing machine setup

Requirement	Golden Setup	XX	YY	ZZ
Delay factor for UDT (in seconds)	0	60	60	60
Throughput signal tapping	Mold Pressing	Mold Pressing	Strip at unloader	Strip at unloader
Data Integrity	Good	Poor	Poor	Poor

2. OEE reporting default setup

In the OEE report, the highest loss is contributed by invalid data. The occurrence of invalid data is based on three scenario below and this is standard across the whole manufacturing plant :

- a. Equipment state is normal production but there are no throughputs
- b. Throughput Cycle Time > 900 second
- c. Throughput's Units > 5000

During onsite study, the equipment is in production mode and producing output, this should be classified as PR (production running) but in OEE report, it shows invalid data. After checking through each scenario, it is observed the throughput's units > 5000 scenario is not met, with the reason that the product produced is small die, with 1 cycle throughput time can go up to 20000 units.

3. UPH deviation between plan versus actual

From our in-house Equipment Automatic Time-Study tool, it is observed that the actual molding UPH ranges from 20 to 28 batches per hour, even with the same product running on the same parameter setting. However, the plan UPH derives from the theoretical calculation is supposed to be 50 batches per hour. After the onsite actual time study collection, it is observed the OEE report system show is based on 1 time 1 cycle, however actual is running 2x per cycle as the 2units are running parallel.

Execution / Action Taken

1. Machine signal setup

In the Improve stage, the equipment engineers and industrial engineer change the machine signals by

- standardizing all molding equipment to benchmark the golden setup,
- follow the same signal tapping location (see Figure 3: The comparison signal tapping location from unloader to mold pressing) and
- reset the 0 delay when equipment is stopped unexpectedly (see Table 3: Example of delay time table on each machine event).

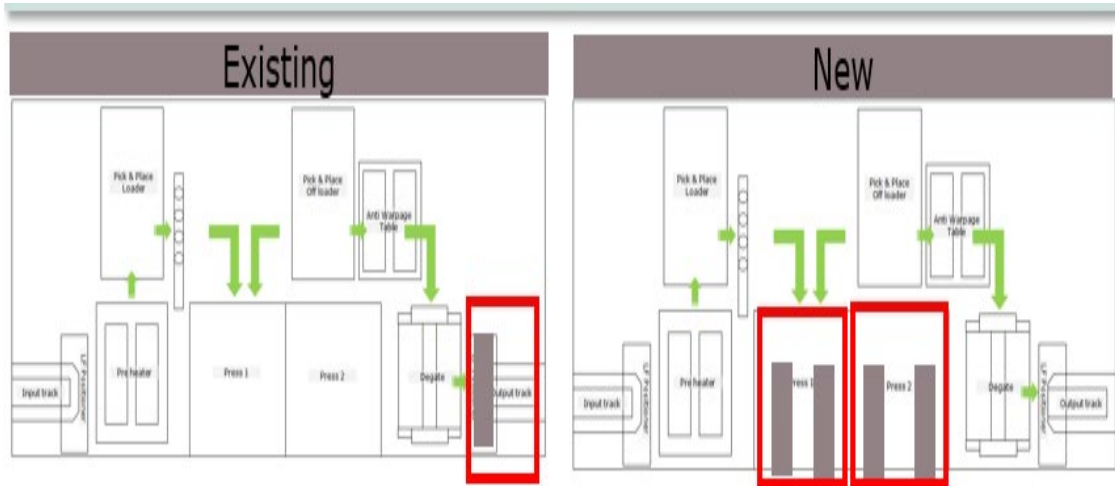


Figure 3: Equipment signal tapping location change from unloader to mold pressing

Table 3: Example of equipment delay time list on each equipment event

EQ TYPE	EQSTAT EVENT	DELAY_TIME
XX, YY, ZZ	UNSCHEDULE DOWNTIME	0
XX, YY, ZZ	STANDBY	5
XX, YY, ZZ	IT/FI Maintenance	0
XX, YY, ZZ	SCHEDULE DOWNTIME	0
XX, YY, ZZ	NORMAL PRODUCTION	0
XX, YY, ZZ	Non Schedule Time	0

2. OEE reporting default setup

Next, the team tabulated a range of existing product running list with the range of 5000 units per cycle to 20000 units per cycle, differentiated by package characteristic. With the list provided, the team work together with factory integration engineer to solve the OEE report's invalid data.

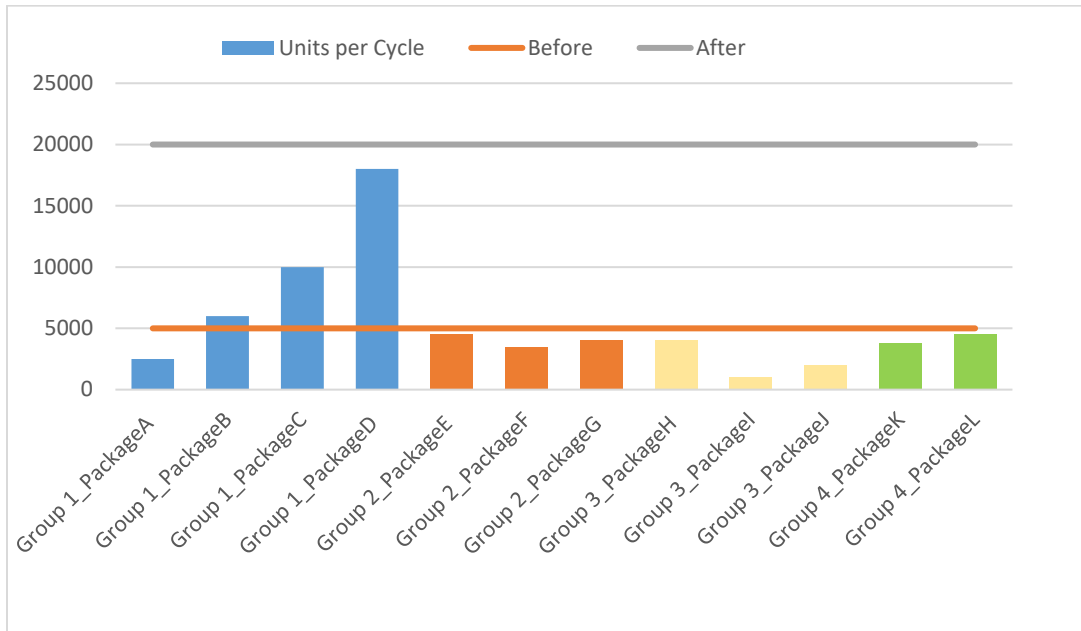


Figure 4: Example of different units per cycle requirement by different package and different group, with the correct setup implementation in OEE reporting for invalid data scenario.

3. Plan data versus actual equipment capability

With the correct equipment signal location rectified, the team performed the actual measurement in the molding process using molding press. It is observed that the equipment is consistently producing in a consistent rhythmically cycle. With enough sample size required collected, plan UPH is updated.

Table 4: Example of snap-shot of the time intervals

Before			After		
Timestamp & Time Intervals		Unit	Timestamp & Time Intervals		Unit
4:26:03am		1	8:33:05am		1
4:26:11am	0 min 08 sec	1	8:36:15am	3 min 10 sec	1
4:28:32am	2 min 21 sec	1	8:38:26am	2 min 11 sec	1
4:28:40am	0 min 18 sec	1	8:41:36am	3 min 10 sec	1
4:35:28am	6 min 48 sec	1	8:43:47am	2 min 11 sec	1
4:35:36am	0 min 12 sec	1	8:46:57am	3 min 10 sec	1
4:37:56am	2 min 20 sec	1	8:49:07am	2 min 11 sec	1

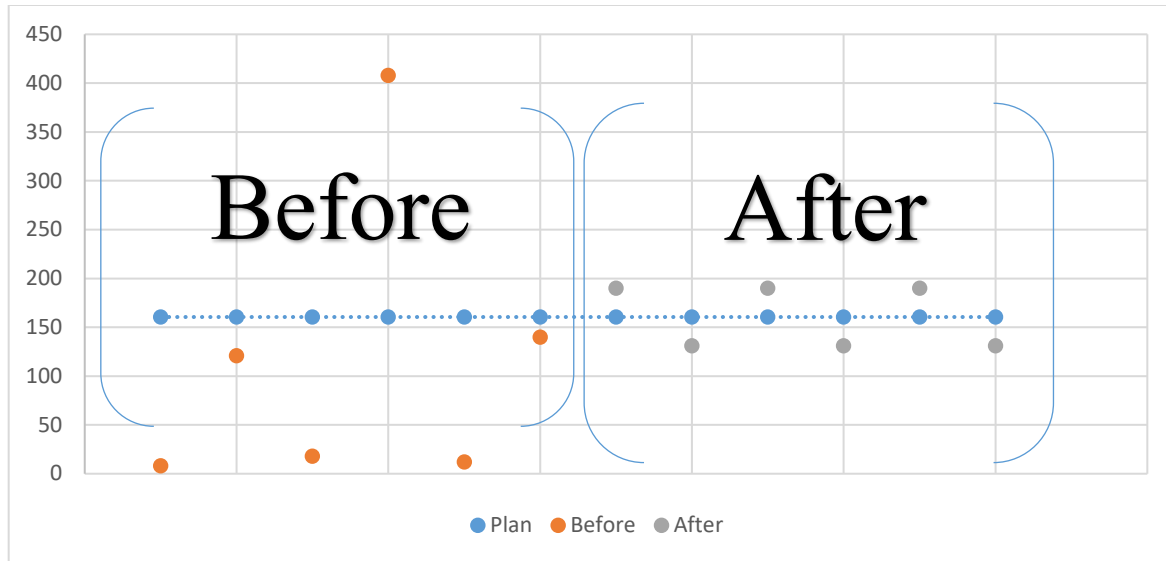


Figure 5: Example of snap-shot of the time intervals plan, before and after

Result

After simulating the actual improvement, it is observed that the average invalid data reduced from 50% to 2.3%, and the average speed loss reduced from 14% to 4%. Both met the target set. Overall OEE performance is improved from 10% to 63% and consistently out-perform the overall target. (See Figure 6 for the OEE Classification for the week 0 to week 16 w.r.t. initial plan OEE).

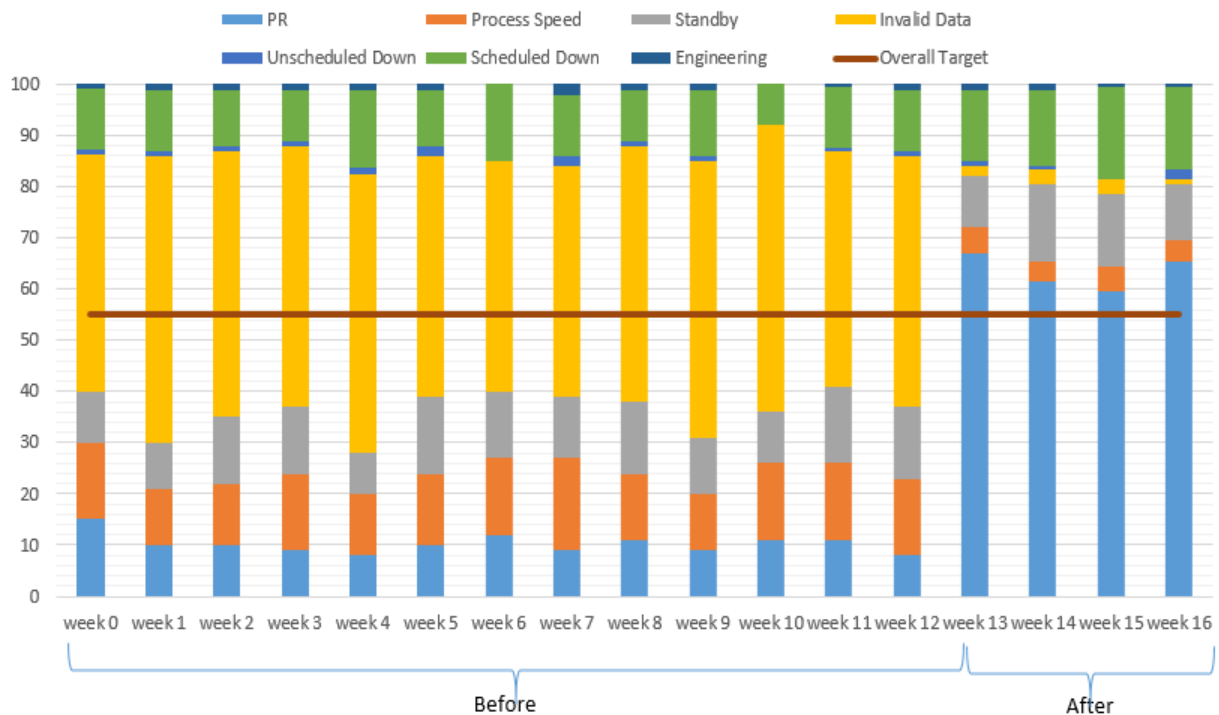


Figure 6: OEE Classification for Week 0 to Week 16 w.r.t. initial plan OEE

With this project, the team is able to achieve two important outcome:

- 1) Standardized the equipment signal system (tapping location, and 0 delay) for unscheduled down scenario by benchmarking the golden setup.
- 2) Perform early triggering with any abnormal deviation observed in the OEE report

This gives the factory and operation the confidence that the equipment is under perfect synchronization following standard machine setup governance, realistic capacity planning and accurate actual performance measurement. This help the team to achieve the right decision on investment avoidance of 510K Euro.

Conclusion

This Synchronization Systematic allows various functional departments of Industrial Engineers, Equipment Engineers, Planners and Operation to align better alignment on equipment performance and capacity commitment following the agreed standard systematic.

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References

- [1] George, Michael L. (2005), *The Lean Six Sigma Pocket Toolbook: A Quick Reference Guide to Nearly 100 Tools for Improving Process Quality, Speed, and Complexity*, New York: McGraw-Hill
- [2] H. Tang, D. Yeo and A. Ding. (2016), *Equipment Automatic Time Study in Semiconductor Manufacturing*, 2016 Industrial and Systems Engineering Research Conference.
- [3] H. Tang, Nyoman, Imsar and Rois (2017), *Application of Equipment Automatic Time Study for UPH Improvement of Orthodyne 7200 and 7200+ Aluminum Wire Bonder*, Asia Pacific Industrial Engineering & Management Systems Conference 2017
- [4] Nelson, Daniel (1980). *Frederick W. Taylor and the Rise of Scientific Management*. Madison: University of Wisconsin Press. ISBN 0-299-08160-5.

Biographies

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