Evaporator Overall Equipment Effectiveness

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Abstract

During times of production ramps in a factory, it is important to have a systematic method to effectively increase capacity in a cost effective manner. This paper discusses a suggested approach and provides an example of using OEE (Overall Equipment Effectiveness) to drive evaporator improvement.

INTRODUCTION

During times of production ramps, fab facilities should use a systematic approach to determine which toolsets will require capital to reach throughput goals and which toolsets will be able to reach factory throughput goals using OEE (Overall Equipment Effectiveness) improvements. The method starts by looking at the gap between current and needed capacity. Cross-functional teams then meet to determine which toolsets can be addressed by OEE improvements, and which will need capital investment.

WATERFALL APPROACH

At the beginning of the planning process, a goal is set for the numbers of wafers that the fab needs to be capable of producing each week. All toolsets are modeled to determine current capacity. Then, as seen in Figure 1, a waterfall chart is created. The blue bars show the outs per week that each toolset is capable of completing. The red line represents what is needed to meet the goal. All toolsets under the red line need to improve. For example, if Toolset 1 represented an evaporator, it would be deemed as a toolset that needed improvement.

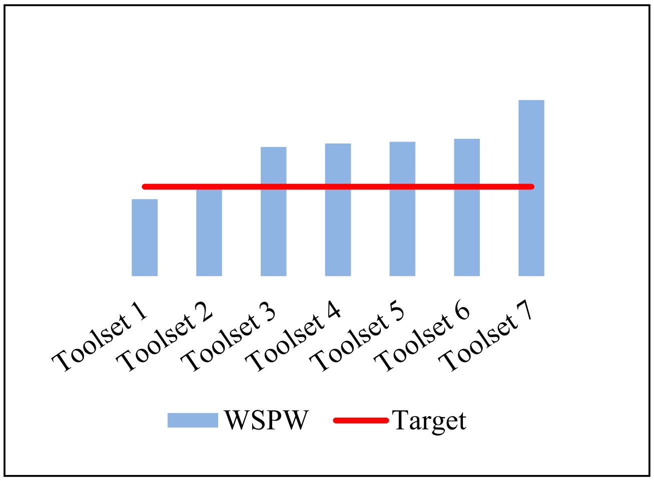

Fig. 1. Generic waterfall chart.

EVAPORATOR UTILIZATION IMPROVEMENT

In order to improve the OEE in the metal evaporation area, data would need to be collected and observations made to see where in the process utilization was being lost. The process should be observed on multiple occasions and across different shifts. Observations should be made from the time the lots arrived at the pre-clean step until the lots are inspected. Utilization data should be analyzed by shift, by tool, and overall. In our example, two main items came to light. First, the amount of time lost waiting on lots coming from the wet pre-clean step. The tools and people would sit idle while lots were in queue waiting to be cleaned. Second, the move-per-hour trend was reviewed and a huge loss was identified in the hour after shift change. These two areas became the focus of the OEE improvement efforts.

DOOR OPEN TO DOOR CLOSED

Evaporators are one of the few manual toolsets left in factories. After a lot completes, the operator manually unloads the tool, cleans the tools, preps the tool with new metal, and then loads the new lot. One challenge in this process is a close couple time between the wet pre-clean step and loading into the evaporators. Due to this close couple, operators are often hesitant to dip lots “early.”

To address the lost time waiting on lots from the acid benches, a goal needs to be established for the operators which could be easily interpreted and also motivated change. The time from when the door opened (a lot is finished), until the door is closed (the next lot is started) needed to be decreased. This is called the "Door Open to Door Closed" (DOTDC.) metric. Data should be gathered and analyzed to see the starting point by shift.

In Figure 2 below from our example, the first column of data from 1/3 to 1/17 shows initial data by shift. The best performing shift, Shift 2, became the benchmark. The goal was for all shifts to be able to match that time.

Start	01/03	01/17	
End	01/17	10/01	% Change
Shift 1	0:53:25	0:45:50	14.2%
Shift 2	0:41:25	0:33:32	19.0%
Shift 3	1:19:01	0:49:43	37.1%
Shift 4	1:03:55	0:40:31	36.6%
All	0:59:27	0:42:23	28.7%

Fig. 2. DOTDC times and improvement by shift.

The first approach taken to reduce the time and meet the benchmark was to designate a dedicated person to dip the wafers. In our experiment, the first shift resisted the implementation of this practice. It was clear that a cultural issue needed to be addressed. Instead of forcing the designated dipper, the metric was rolled out to the entire team to meet in whatever way they were able. At the start of every week, data was sent out to the supervisors and operators so they knew exactly where they stood. This also became part of the area lead's key performance indicators (KPIs). Using this metric, operators were encouraged to make sure lots were ready to be dipped when they needed to be. The benches were shared, but the floor staff was told that the evaporator lots had priority. This helped limit the bulk processing that had been occurring at these benches.

As this metric was monitored week to week, all shifts showed improvement, including the benchmark shift. To close the performance gap between shifts, area leads were swapped and worked overtime between shifts to share best practices. This helped drive even more improvement. For example, the benchmark lead recognized the importance of having buy-in from the equipment and process technicians to ensure tools were quickly maintained preventatively and brought back from qualifications. This best practice was shared across all shifts.

To help improve visibility, large monitors displaying the status of each tool were provided. The tool changes colors depending on the state. The tool icon also started blinking when the tool started venting. This is the indicator to the operators to start dipping a lot for the tool.

During the nine months that the data was tracked, the other shifts were not able to match Shift 2, but they did all improve. Shifts 3 and 4 had the largest starting gap. As can be seen in Figure 2, they were also able to drive the largest improvement.

SHIFT CHANGE

The next area addressed was the variability seen at shift change. As seen in Figure 3 below, the hour after a shift change produced significantly less moves than any other hour of the day.

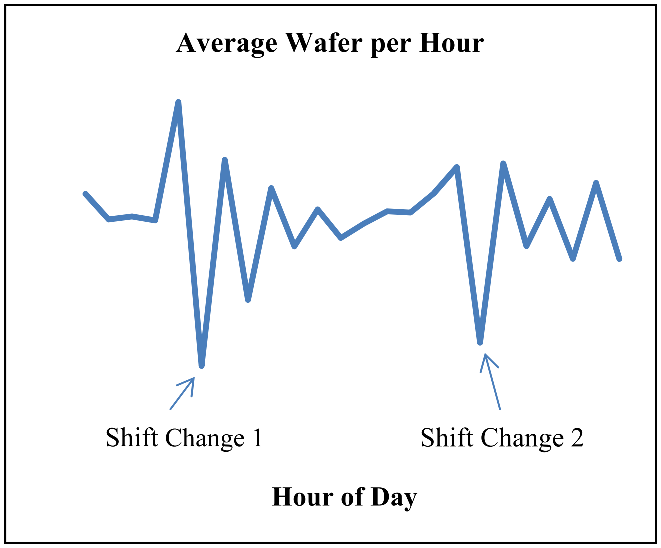

Fig. 3. Evaporator moves vs. time.

Based on perceived efficiency, a practice had evolved that operators would wait to load tools during the last hour of their shift. This ensured that all tools they would be running when the next shift started. Unfortunately, this also caused most of the tools to complete runs around the same time. Since there are fewer operators than tools, this practice caused tools to sit idle waiting to be unloaded during the hour after shift change. It would take a few hours to recover before things smoothed out again.

To track this effect, a metric was created to monitor the number of moves during the first hour of the shift compared to the rest of the day. The operators were told to change their practice of waiting to load lots at the end of shift. It was explicitly stated that operators should operate the same at the end of the shift as they did the rest of the day. Following this strategy, the average number of wafers coming out during the first hour of the shift should be approximately the same as any other hour of the day.

Over time, the shifts were given a more difficult goal to reach in order to start smoothing out this data. It was known that it would still be slightly different at shift change, but the goal was to make the shift change as smooth as possible. Figure 4 below, shows the percentage change from the first quarter to the third.

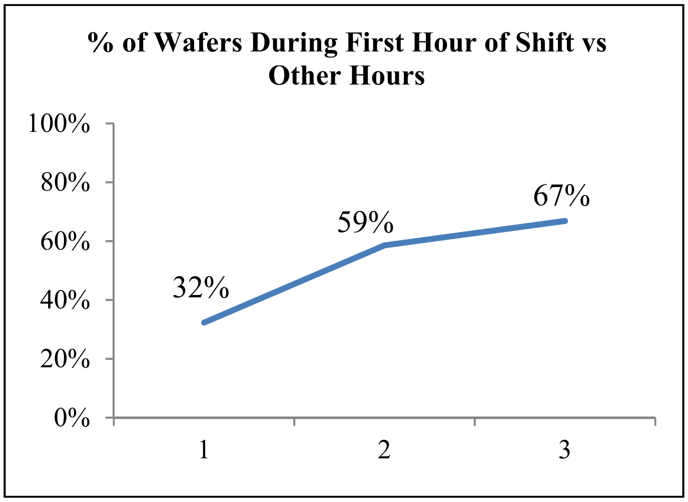

Fig. 4. Percent of evaporator moves during first hour of a shift vs. all other hours in the day.

Change can be difficult from cultural perspective. It needs to become part of the area's KPIs before change was seen. The data was reported in the same weekly report as the DOTDC metric.

Another idea to drive further improvement is to have some people work a slightly offset shift, so that not everyone is coming and going at the same time. This would be expected to help with smoother pass downs as well as help continue to smooth out the moves per hour.

Conclusions

By creating visible metrics, establishing a reward system, and empowering everyone involved in the metal evaporation area, OEE was improved by approximately 10% in a nine month period. In this example, the team's success eliminated the need to purchase an additional evaporator, allowing precious capital to be spent on other tools.

Acronyms

OEE: Overall Equipment Effectiveness
DOTDC: Door Open to Door Closed
KPI: Key Performance Indicators