

DELTA HANDLER OVERALL EFFECTIVENESS IMPROVEMENT THROUGH WASTE ELIMINATION

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ABSTRACT

This paper presents a case study to on improvement of less than satisfactory overall equipment effectiveness (OEE) of the Delta Handler from 65 percent to a target OEE of 80 percent.

The study adopted the Just-In-Time manufacturing philosophy for identification of wastes and minimization or elimination of over-processing and waiting time in order to improve the OEE. With the waste elimination mindset, the OEE metrics such as availability, performance and quality rates were updated after a few improvement actions. By thorough investigation and improvement efforts, three areas of improvements were addressed by eliminating time wastage. First of all, it was uncovered that the handler had a device mis-contact in which the device pads were misaligned to the handler socket resulting in various jams. Effort was put into this matter to realign the contact and subsequently reduce jam time. Secondly, testing on the handler was not at its maximum parallelism. Despite the handler was capable of testing up to 8 sites, however only 6-7 sites were used most of the time. The handler polls continuously for result from an empty site until a timeout. Time is wasted during the unfruitful polling and the handler outputs a lower unit per hour (UPH) at a lower parallelism. Lastly, the boat transport was known to be the cause of most jams in the handler where mean time between assist (MTBA) to service the jam became long enough to lower the OEE of the handler. Significant engineering Improvements were made to all these 3 areas resulting in an improved handler OEE. As equipment engineering technicalities become very complicated in resolving some of the handler problems, this paper has no intend to delve into the intricacies of the mechanics of the Delta handler. The scope of the paper is subjected to the Delta handler OEE improvement through waste elimination efforts. Product yield improvement activities were undisclosed to protect the company's process flow information. The Company will be able to reuse efforts of this paper to improve other equipments OEE through waste elimination. This paper serves as a guideline to others who wish to use JIT to improve manufacturing processes and equipment utilization.

Keywords: Just-In-Time (JIT) manufacturing, overall equipment effectiveness (OEE), waste elimination, mean time between assist (MTBA), unit per hour (UPH), parallelism.

1. INTRODUCTION

Total productive maintenance (TPM) focuses on systematic recording and elimination or minimization of 6 to 8 big machine related losses. These include yield losses, process defects, reduced speed, idling and minor stoppages, setup and adjustment time, equipment failure, manpower related losses. A summary measure of these losses is popularly known as overall effectiveness (OE), which depends on availability (A), performance (P) and quality (Q). The exact definition of OE differs between applications such as overall assembly effectiveness (OAE), overall plant effectiveness (OPE) or overall equipment effectiveness (OEE), and authors. Nakajima (1988) [1] was the original author of OE and De Groote (1995) [2] is one of several authors afterward for continuous and intermittent production. Despite having different definitions of OE Nakajima [3] asserted that under ideal conditions firms should have rates of $A >$

0.90 , $P > 0.95$ and $Q > 0.99$. These figures would result in an $OEE > 0.84$ for *world-class* firms and Nakajima considers this figure to be a good benchmark for a typical manufacturing capability.

Overall effectiveness is a particular measure of earning capacity, or, in other way around a measure of lost capacity [9]. Even one percent improvement of OE can bring about a significant impact on value addition to company activities. TPM activities can enhance remarkable improvement of OE without much expenditure except the development of human capital which has wide spread advantage for the organization. Besterfield *et al.*, (1999) [4] wrote, "TPM is keeping the current plant and equipment at its highest productive level through cooperation of all areas of an organization". Just-in-time (JIT) as a manufacturing philosophy is well known in championing on elimination of waste or losses in the total manufacturing process. A successfully

implemented JIT system enables a company to get hold of a strategic leap [5]. As part of the JIT system, there is a need to define the following three basic and squarely important components for eliminating waste.

(1) Establishing balance and synchronization and flow in the manufacturing process, either where it does not exist or where it can be enhanced.

(2) Company's attitude toward quality, the idea of "doing it right the first time".

(3) Employee participation though autonomous small group activities. It is a prerequisite for waste elimination. Every member of the organization—from the shop floor to senior management—has a part to play in the elimination of waste and solving the manufacturing problems that cause waste. The only way a company can solve hundreds or even thousands of problems that occur in a manufacturing system—from small problems to large—is total employee involvement.

The last two components are common to TPM and JIT systems. The common objective of JIT and TPM is to provoke a sense of joint responsibility between supervisors, operators and maintenance workers, not simply to keep machines running smoothly, but also to extend and optimize their overall performance. Jointly, TPM and JIT can create a productive manufacturing environment [7].

Womack *et al* (2003) define waste as any activity that consumes resource but adds no value as specified by the customer. To remain competitive in today's business, the focus is on lean manufacturing by eliminating waste to add value to all activities. In order for manufacturers to understand the waste within manufacturing activities, Ohno (1988) specified waste up into 7 elements, namely Overproduction, Over-processing, Waiting, Transport, Inventory, Motion, and Defects.

The existing OEE of an important machine named Delta Handler is about 65 percent, which is far below the expected level. This paper explains how the overall equipment efficiency (OEE) has been improved by reducing wastes in over-processing and waiting.

2. THE CASE STUDY

A case study was done on the availability and performance of an important machine known as Delta handler. The Delta handler is crucial to the production system as it replaces human intervention of transferring the devices onto the automatic test equipment (ATE). The Delta handler performs picks and place for surface mount devices. It interfaces between a printed circuit test board and automatic test equipment (ATE). Handlers can easily be re-tooled to handle new packages. The handler consists of an input and output boat and a soaking chamber. The handler picks devices from the input boat where the input boat slides into the soaking chamber. Once testing has completed, the devices are placed into the output boat and the handler picks devices and puts them on trays.

2.1 Problem and Root Cause Identification

Waste identification can better be done using the lean manufacturing concept than traditional approach as the former is providing with focused definitions on the

subject matter. Figure 1 illustrates that nonvalue added actions or waste is getting more visible in the lean orientation.



Fig 1: Waste identification and redefining the production lead time

The improvement of the Delta handler OEE was done by removing waste of over-processing and waiting. As the study aimed to improve OEE, a time study was conducted on all the handler processes and movements. This had unearthed that a large amount of time was taken for handler's indexing (Figure 2). The indexing time was increasing every time a device miscontact was happened. This also caused jams which adversely affected the performance of the machine.

The second biggest problem was handler timeout or waiting, which was obviously a waste. This happened when not all test sites were enabled and the handler polled for result from a non-responding site. This Delta handler normally runs on parallelism of 8 sites. Due to inadequate maintenance, 1 or 2 sites were found unable to function during the testing. These test sites reduced the performance and hence OEE value.

The Mean Time Between Assist (MTBA) increased when handler jams occurred frequently. Assistance in the form of maintenance and repair required downtime of the equipment that reduced the availability of it. The MTBA is a type of waiting waste in JIT philosophy and considered to be reduced.

2.2 Device Mis-contact Improvement

Device mis-contact was identified as a problem that plagued the handler. It increases the possibility of jams. The equipment engineering team of this Company using the machine worked with the Delta design engineers where the input boat setup design was improved and re-targeted. The team also developed a software tracking system to track preventive maintenance (PM) schedule based on the life cycle rate of the handler. Henceforth, PM activities need no longer be scheduled again and again but could be performed dynamically based on the software tracking system.

Figure 3 shows that an improvement of 0.001 percent in device mis-contact contributed 5 percent to OEE improvement. The mis-contact improvement of 0.001 percent is the alignment of the device pads to socket contact measured in area (μm^2).

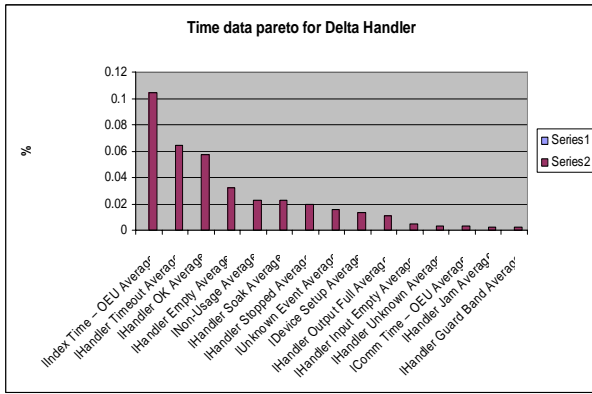


Fig 2: Time Pareto for Delta handler processes and movements

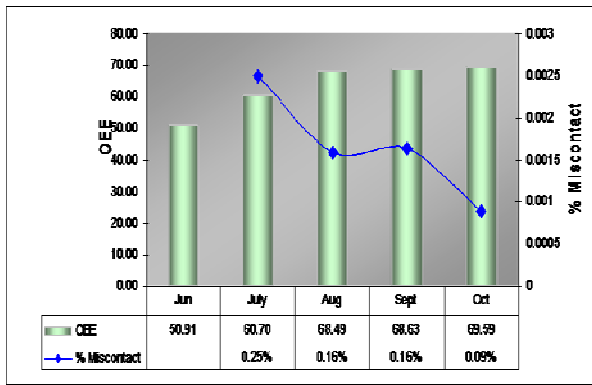


Fig 3: Effect of device mis-contact reduction to OEE improvement

2.3 Disabled Test Sites

Due to the lack of preventive maintenance practices, the handler 8-site parallelism was reduced to 6 or 7 sites. The unused sites caused the handler to be polling continuously for results until the timeout. This is a direct waste of time. Moreover, the unit per hour (UPH) which is a measure of equipment performance reduces with 8-sites parallelism. This issue was easily resolved by fixing all handlers with 1 or 2 faulty sites, bringing the handler parallelism up to its maximum and optimum state.

UPH improvement tied directly to performance improvement. Figure 4 shows at 6 seconds of test time, x8 parallelism has a UPH of 4200 while x6 parallelism records UPH of 2000.

2.4 Mean Time Between Assist (MTBA) Reduction

An effort was taken to reduce MTBA by reducing jams. Jams were the main reasons the handler would need to be downed and time was wasted during such events to service jams. Once again handler jam types were analyzed and the Pareto diagram in Figure 5 shows that the boat transport contributed the highest incidence of jams. The MTBA for one of such jams was about 0.5 hours. The recurrence of 211 times of boat transport jam in a month resulted in a cumulative MTBA of 105.5 hours, equivalent to 4.5 days.

As soon as the boat transport jam was identified, the

equipment engineering team worked relentlessly to resolve the boat transport issue by greasing the boats more often and changing them as necessary. Old boats that exceeded their life cycle of 3 years were sent for chemical de-oxidation. De-oxidized boats could however be used for another 3 years. Boats that exceeded 6 years must be scrapped. After this action, MTBA was reduced gradually from 0.6 to 0.1 percent in 5 months with the significant reduction of boat transport jams.

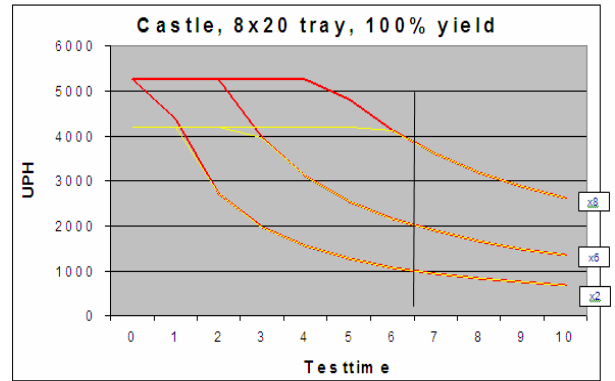


Fig 4: UPH improvements with increased number handler parallelism

3. RESULTS AND DISCUSSION

The device mis-contact improvement was reduced by 0.001 percent by realigning the contact area of its pad to socket contact. Prior to this activity, the OEE of the handler stood at 65 percent. By realigning the contact area and thus improving the performance, the OEE was increased to 69 percent. Table 1 shows the calculation. The yield and availability of the handler remained at 91 percent and 79 percent respectively.

Table 1: OEE Calculation with Device Mis-Contact Improvement

Action	Availability	Performance	Quality	OEE
Before alignment	0.79	0.9	0.91	0.65
After alignment	0.79	0.958	0.91	0.69

By enabling test sites from x6 to x8 parallelisms, the performance (UPH) of the handler improved to 97.8 percent. Reduction in boat transport jams and that of MTBA increased handler availability to 81.05 percent (Figure 6). Yield increased from 91 to 92 percent with slight improvement in product quality. Table 2 shows the result of waste elimination exercise that was put in place of handler OEE improvement brought the OEE up from 65 to 81 percent.

A massive improvement was seen in MTBA reduction through the resolution of boat transport jams. Enabling test sites from 6 to 8 parallelisms yielded a small 1 percent OEE improvement. It is no surprise that the company did not emphasize in enabling all test sites. The handler polling timeout due to absent of a device was very minimal in this case.

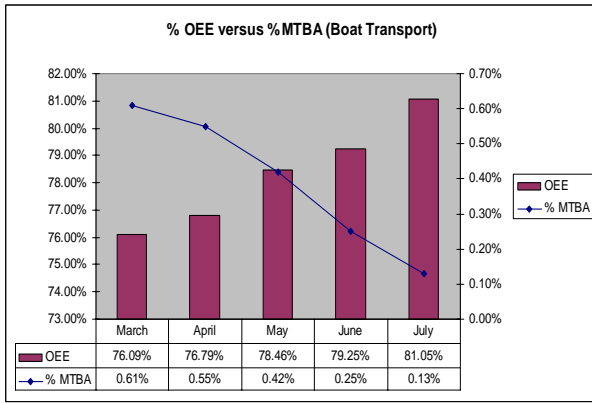


Fig 6: Relationship between OEE and MTBA over a few months of implementation

Table 2: OEE Calculation with Waste Elimination efforts

	Availability	Performance	Quality	OEE
Before	0.79	0.9	0.91	0.65
After alignment	0.79	0.958	0.91	0.69
After test site enabled	0.79	0.978	0.91	0.70
MTBA reduction	0.9008	0.978	0.92	0.81

5. CONCLUSIONS

The study applied a joint approach of TPM and JIT in a manufacturing unit. The study has achieved the goal of improving the overall equipment efficiency of the Delta handler from 65 to 80 percent in a time frame of 1.5 years through waste elimination in equipment engineering. The methodologies applied in this paper serve as a good guideline to the company for further improvement in case of other equipment as well. OEE improvement could bring momentous business margins. There is also an opportunity to delve into yield improvement of the tested product by increasing quality and output of the Delta handler equipment which would further heighten the OEE metric. Additionally, this paper explains OEE calculation that is crucial for equipment and process improvement. Future work can be done to fan-out the OEE improvement to other equipment in the company or elsewhere.

6. REFERENCES

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