

Cycle Time Reduction Through Event Based Management Approach in 300mm Wafer Foundry

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ABSTRACT

The heart of any semiconductor manufacturing business is the fab, where the integrated circuit is formed on the wafer. Typically, it takes from 40-60 days depending on the number of metal layer, to complete the fabrication process. For 300mm fully automated foundry, the challenge is not only due to product mixes, that have difference flows and difference number of steps that impacted overall cycle time but also in managing automation efficiency that replace human to load and remove product into the equipment that cause equipment idle time and also product waiting time. The objective of this project is to improve idle time or white space in lot Gantt by replacing existing polling mechanisms for lot dispatching with real time event triggers in 300mm fully automated wafer foundry. The new method introduced utilizes advanced execution systems that automatically respond to changes in the manufacturing execution system (MES), adding continuous direct lot movement from equipment to equipment in the unified AMHS system according to the intelligent dispatching rule policies. The development of this advanced scheduling system uses Activity Manager (AM), a commercial application of the Advanced Productivity Family™ (APF) suite, integrated with dispatching rule policies in RTD and MES as a platform to execute real time transactions for lot dispatching. The results show 50 percent improvement through reducing white space between previous processing time to next processing time, which indirectly improves overall machine load port white space. The real time execution system has been successfully integrated and implemented in a real 300mm wafer foundry production shop floor.

Keywords: Overhead Transportation (OHT), Manufacturing Execution Systems (MES), CMOS (Complementary Metal Oxide Semiconductor), AMHS Automated Material handling Systems and Real Time Dispatch (RTD)

INTRODUCTION

Semiconductor manufacturers are face with stiff competition as more global capacity is being added (Mohd Azizi et al. 2002). Intense competition has resulted in semiconductor manufacturers initiating drives to improve their market responsiveness by reducing the lot cycle time whilst narrowing the overall cycle time distribution to achieve greater repeatability. The drive for higher utilization comes from the capital-intensive nature of 300mm wafer foundries – 1.3 to 1.8 times of 200mm.

The foundry environment is probably one of the most complex manufacturing systems in terms of equipment, manufacturing routes and product mix (Kader et al 2003). This project was initiated to reduce bullet lot cycle time to achieve world class manufacturing standard by means of a highly responsive dynamic system. This paper describes the implementation of Activity Manager to achieve direct equipment-to-equipment lot delivery capability through a real time execution system and the results achieved.

PROJECT APPROACH

In fully automated 300mm wafer fabrication facilities, optimum usage for AMHS systems is one of the key contributors to lot cycle time. Traditionally, upon process completion in equipment, a carrier, or Front Opening Unified Pod (FOUP), would be sent to a stocker where it would wait to be re-dispatched to the next equipment. Figure 1 shows a Gantt chart from a lot perspective under the traditional scenario. After a depth analysis, there is great opportunity for lot cycle time improvement by minimizing y time.

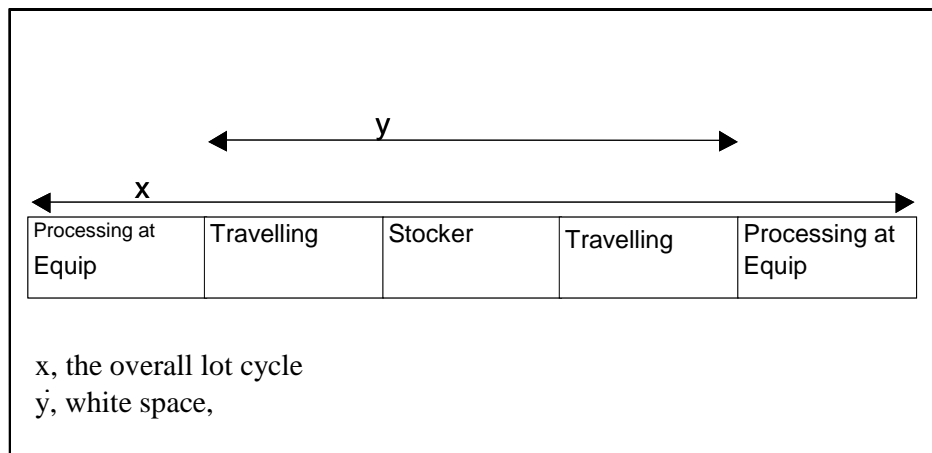


FIGURE 1: Traditional 300mm Lot Gantt

Figure 2 shows a Gantt chart from a machine perspective under the traditional scenario. This shows opportunity of machine utilization improvement by minimizing b time. In summary, reducing b and y times in short cycle time tools will significantly improve overall white space or equipment waiting time. This indirectly contribute to improve the lot traveling time by more than 50% due to single travel time is required since the lot does not return to stocker after finish process but rather the lot is delivered directly to the next equipment once it finish process from previous step. This idea is shared with McIlvaine 1999; Rust, Wright, and Shopbell 2002; Pillai et al. 1999, who have described the potential of an AMHS to improve and maximize equipment productivity and wafer delivery.

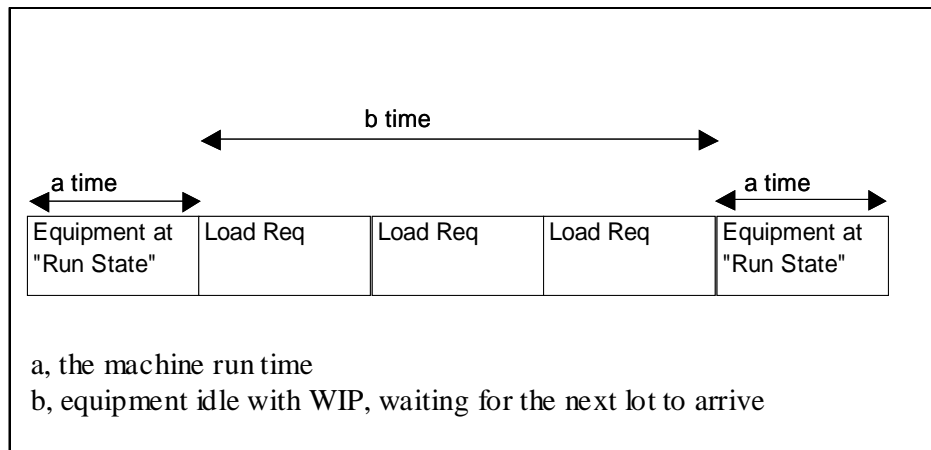


FIGURE 2: Traditional 300mm Machine Gantt

In order to reduce the b and y times and achieve direct equipment-to-equipment transfer capability, the first step undertaken was to replace the existing polling mechanism used by the MES with real time event tracking and execution. In addition, its also can customized to shorten the time taken for the algorithm calculation during the RTD whereNext and whatNext procedures as Figure 3 below. In this project we also consider respective equipment load port as equipment due to its processing nature and cycle time.

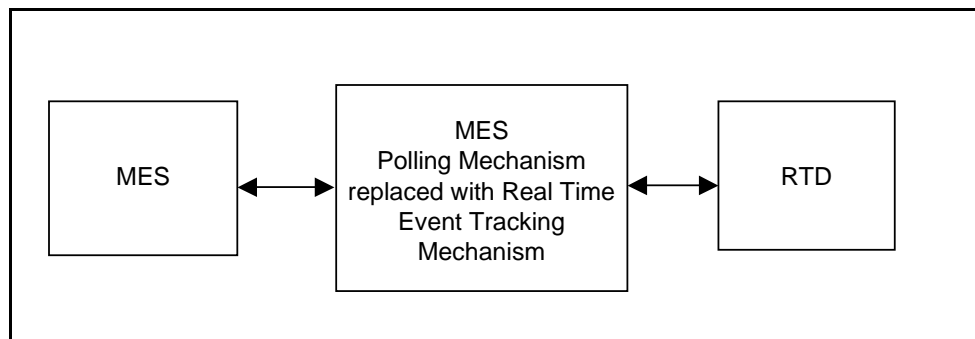


FIGURE 3: MES-RTD Architecture

RESULT AND DISCUSSION

After implementing activity manager, where equipment-to-equipment lot delivery has set to available, a set of data has been collection and analyzed. In this paper, the measurements below have been highlighted

- Bullet lot Gantt during intra-bay transfers
- Bullet lot Gantt during inter-bay transfers
- Machine Load Port Gantt

Figures 4 and 5 show the average white space for bullet lot during intra-bay and inter-bay movements respectively. From the results, a significant improvement of 57% is achieved intra-bay transfers, with a similar 46% improvement for inter-bay transfers, after the AM implementation. All of this is due to lots not needing to return to the stocker, but instead are able to be transferred and processed directly in the next equipment.

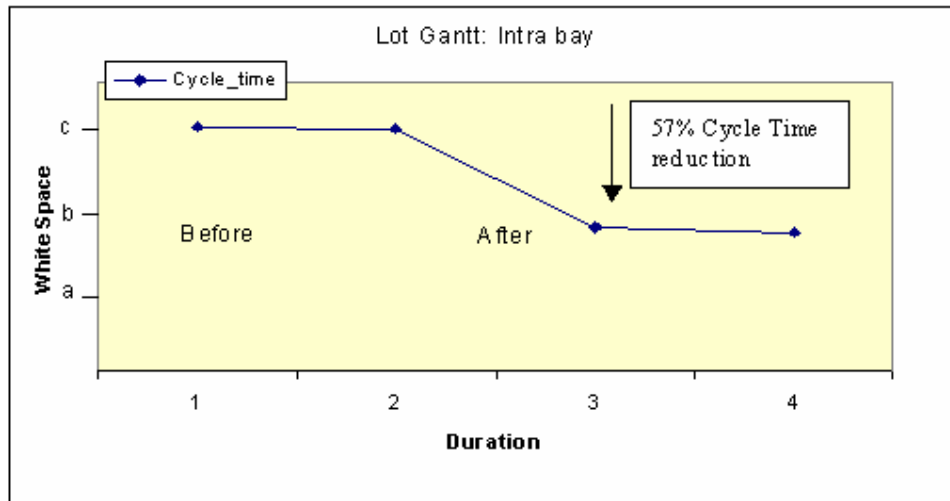


FIGURE 4: Bullet lot Gantt during intra-bay transfers

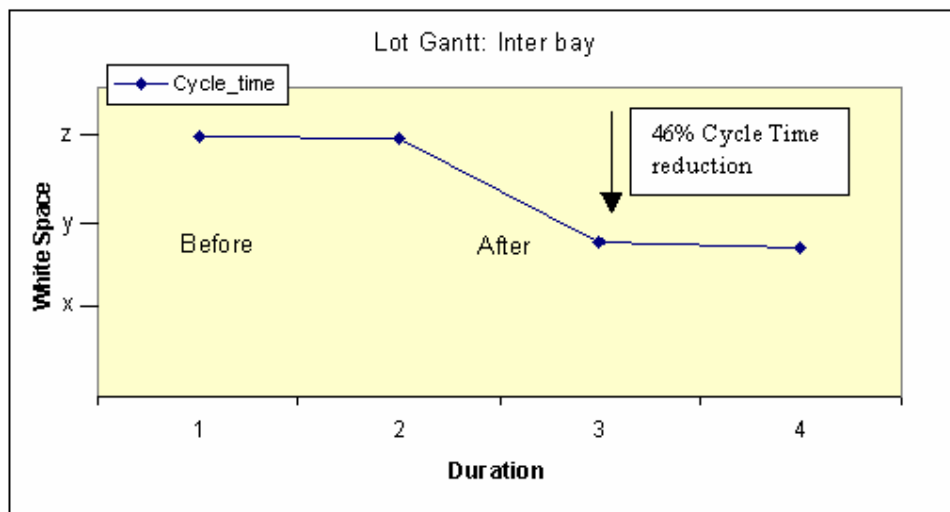


FIGURE 5: Bullet lot Gantt during inter-bay transfers

The machine load port Gantt white space on high throughput equipments during the period of AM implementation is shown in figure 6. The machine load port Gantt white space drops from 18.4% to 11.5%, resulting in increased overall machine utilization by more than 10% after the implementation.

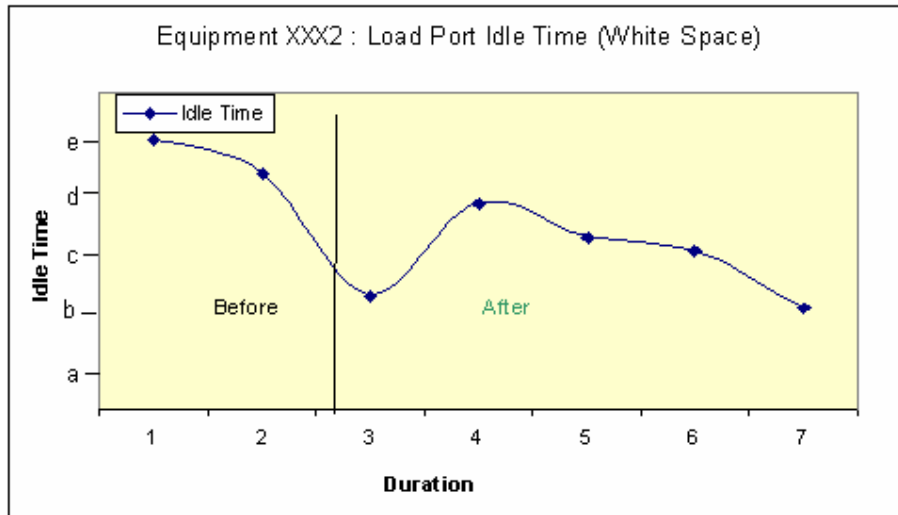


FIGURE 6: Machine Load Port Gantt

CONCLUSION

The challenge in this project is to find most stable architectural design, integration and impact on automation operation in handling exceptional scenarios. Most of this challenge has been achieved through inter-department teamwork including the RTD, CIM, manufacturing, process and equipment engineering teams. This project is being implemented smoothly and has support from top management for it to be used and executed FAB wide. The design-to-implementation process was efficient, taking only 43 days to achieve the first equipment-to-equipment transfer, the fastest equipment-to-equipment integration effort to-date. The implementation has produced positive results in the following areas – intra-bay bullet lot carrier exchange time improved by 57%, inter-bay bullet lot carrier exchange time improved by 46%, and equipment idle time dropped from 18.4% to 11.5%. As the improvement works is being done, its reveal more works need to be completed to achieve first class cycle time and optimum equipment utilization. Future plans for improvement include preemptive dispatching and lot scheduling.

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