Simulation as a Tool for Cycle Time Reduction, Equipment and Staffing Utilization, and Capacity Planning and Scheduling

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ABSTRACT

Discrete event simulation is an effective tool for considering various manufacturing scenarios and providing information for capacity and planning decisions. Motorola's most innovative GaAs wafer fabrication facility, Compound Semiconductor 1 (CS-1), has modeled their wafer fabrication operations and requirements with a state of the art discrete event simulator called ManSim, from Tyecin Systems Inc. ManSim is an adaptable simulation system to model the complexities and realistic details of semiconductor operations. Inputs into the model range from equipment set, staffing details, operation rules, and process steps. Outputs generated from the software include lot completion dates, throughput and cycle times, asset utilization, and capacity information. CS-1 now has the ability to capture their entire wafer fabrication process, run accurate simulations quickly, and justify capacity and planning decisions. This paper describes how CS-1 has utilized discrete event simulation to analyze fab operations to determine how to improve cycle time, asset utilization, and capacity and planning in our facility.

INTRODUCTION

Although relatively unique in nature, CS-1 is like many other organizations who want to produce the highest quality parts in the shortest amount of time. One relatively new and unique way of understanding this ideal condition is through discrete event simulation. Discrete event simulation has long been used but its technology gap and lack of commercial and customer support have prevented it from being more widely used today. Traditionally, methods of applying spreadsheets to compute cycle time, capacity and manufacturing performance have been incapable of the quick and extensive results that a computer based simulator can generate. When you consider all the intricacies of wafer fabrication, it's not only hard to pinpoint the exact trouble spots in the line but it's even more difficult to solely base manufacturing decisions on routine knowledge of your factory. ManSim is the break of that routine, and consequently has helped CS-1 see the impact of adding a third shift, changing their product mix, adding new equipment, cross training their operators, and utilize a plan to double their capacity while reducing cycle time by 20%.

HISTORY

In the beginning stages of developing a model, there are numerous variables that need to be inputted, ranging from equipment and operator specifications to product and process definitions. Developing a methodology to help organize and maintain that data is also imperative. Ultimately, your model will need reliable and valid data to be successful, and using that data will help generate accurate results. Justifying the validity of that data is also a time consuming effort as well. For CS-1, it took six months to complete the maturity stride of data crunching and model fine tuning to get where it is today. I believe there are two main factors that contributed to that level of success. The first is CS-1's preference to track lots down to the recipe level (lower), and not stopping at the operation level (higher). The benefit of this is our ability to capture more detailed information like equipment performance, step yield, and recipe process times. An operation step can include numerous recipe's, but for us to capture both, has allowed our simulations to provide a higher level of detail. The second is that CS-1 was set up to be a low volume facility. For a higher volume facility, that amount of detail is much harder to reach and requires an ample amount of time and effort to achieve.

STRATEGIES & RESULTS

Using the most detailed and accurate data is always the best case for simulating effectively. One of the first tests done to analyze that effectiveness was comparing theoretical data to simulated and actual data.

The first step in this process was collecting the theoretical data. This data was gathered from two sources; recipe history in the WIP tracking system (PROMIS) and manual time studies. The second step was extracting actual data from PROMIS, massaging it and dumping it to a spreadsheet. The final steps were running simulations, extracting the simulated cycle times out of ManSim, formatting all three sets of data into spreadsheet form and then feeding that spreadsheet into graphical format. Once these graphs were generated we could then analyze the same stage from three different cycle time perspectives. One of the best features of this graph is seeing the apparent difference in cycle time between simulated and actual data. This difference will not only show how accurately your model is performing against actual data, but will also portray important equipment and performance trends right down to the recipe level. There are several key factors to consider when analyzing those trends; understaffing operators, insufficient cross training, and poor equipment utilization.

Understaffing is the case where you have product at a machine but no one there to process it. In this case there are two decisions that need to be made; hire a new operator, or cross train an appropriate operator either in the same or different area to work that machine.

Equipment utilization is another case where we scrutinized equipment's failure and repair rates, and planned maintenance schedules. As a result, our models percent busy and down time statistics for equipment accurately reflected what was being tracked by PROMIS. Once we accounted for these details we were able to understand and explain the similarities between our actual and simulated data.

One of the main questions facing management today is "What is your capacity?". CS-1 interpreted that question into their own words and asked "What is our capacity if we ran under current conditions, if we implemented a third shift (no weekends), and if we ran 24 hours a day, 7 days a week?". As you can see, as we ramped up our start level, our cycle time exploded (as you would expect). The benefit from this graph is being able to see where your "knee" (or explosion) in the curve is and attack its problem areas. The benefit of capacity simulation is that investigating the "knee" can easily be done by looking through your simulation statistics, reports and definition screens. Using this simulated information, a person could not only justify the cause of the knee, but could determine the priority of areas in the factory that need to be scrutinized first. The effect of fixing those problem areas will result in a pushing out of the knee in the curve. But, to gain an accurate measure of capacity without a simulation model would require spending countless hours of time processing data and performing calculations that could otherwise be spent analyzing and reviewing simulated data.

Till recently, CS-1's simulation efforts have focused on the accuracy of their model and whether or not that model reflected actual performance. A project was put together to map out CS-1's capacity goals for 1993. Each quarter was given a certain start rate and cycle time goal. The simulators purpose was to incorporate any expected factory assumptions, and for each quarter tell what its capacity would be. The graph depicts what would happen if the assumptions remained the same for each quarter and its start level was ramped up. Some of the assumptions in the simulations were new equipment coming on line, new operators for our incoming third shift, better equipment uptime, and reduced cycle times. At 1.88X starts/week (where our Q4 goal is) we are planning to reduce cycle time by 20% which will bring our cycle time down to 240 hours. The biggest simulation task for this project will be mapping out and prioritizing recommendations for each discipline to help make that 20% reduction.

CONCLUSION

Simulation has proven to be an effective and valuable tool in understanding the intricacies of CS-1's operations. Through its start up, evaluation, and now its operational phase, CS-1's model is able to improve fab efficiency and support capacity and planning decisions. Simulation modeling has significantly contributed in capturing our manufacturing processes and justifying our fabrication performance. Consequently, ManSim has allowed us to monitor our theoretical and actual cycle times, understand more closely our operator and equipment performance, play "what if" scenarios to analyze production strategies, and finally, implement it as a planning and scheduling tool to incorporate actual operations.

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