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PREDICTION OF LOT STEP ARRIVAL TIMES IN SEMICONDUCTOR MANUFACTURING

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ABSTRACT

The challenge of making better dispatching and scheduling decisions in terms of bottleneck tool area management and the optimization of batch sizes can be costly and difficult to implement. Current methods using average cycle-time or queue-time controls do not fully represent the current state and true capacity of the fab. In order to improve the effectiveness of downstream productivity processes such as area schedulers or dispatching policy improvements, accurate lot step arrival time predictions are required. Applied Materials, along with a large 300MM semiconductor device manufacturer based in Asia, recently deployed (2019) an integrated prediction engine along with optimization based area scheduling solution to improve bottleneck area throughput with flexibility to adapt to changing business needs and operational scenarios. The following use case will present the solution, benefit and results of the prediction engine deployment.

1 INTRODUCTION

Dispatching and Scheduling challenges are becoming more complex as technology and workflows change over time. Discrepancies between the capacity of the fab and customer commitments lead to equipment inefficiency or unfulfilled customer demand. Dispatching challenges can include tradeoff analysis, difficulty in predicting future events. Scheduling challenges can include out-of-date lot data and difficulty adapting to unexpected events in the fab. Integrating the benefits of both dispatching and scheduling while addressing their stand alone challenges was the focus of the recent prediction engine and scheduling area solution deployment at a 300MM semiconductor device manufacturer in Asia.

2 PROBLEM STATEMENT

Decision improvement in dispatching and scheduling relies heavily on up to date lot status information and future predictions of lot step arrivals for equipment. To improve the effectiveness of a bottleneck equipment area, tool idle time and number of setups need to be minimized. Without lot step arrival times by equipment, schedules and dispatching updates may not be optimal causing fab capacity to be restricted. Optimal batch sizes may also be difficult to achieve.

3 PREDICTION ENGINE APPROACH

Addressing challenges caused by data that is too far out of date to provide accurate lot step arrival times for equipment has been developed using the power and benefit of simulation technology. The core of the prediction engine is the AutoSched® simulation platform. An overall view of the prediction engine

simulation solution is shown in Figure 1. Data preparation occurs prior to simulation execution and uses the conversion of data from external, integrated systems into standard schema tables used by the prediction model. In order to provide the most up to date lot arrival status information to area schedulers, multiple types of prediction simulations are executed. Full prediction simulation results provide the current status of each lot in the fab and expected arrival times at equipment. Update prediction simulation runs are run more frequently than full prediction runs and focus on hot lots and active WIP step arrivals. Data is automatically available to area schedulers and productivity analysis tools for use. The scheduling of prediction runs provides continuous up-to-date lot arrival information which improves the efficacy of scheduling and dispatching systems.

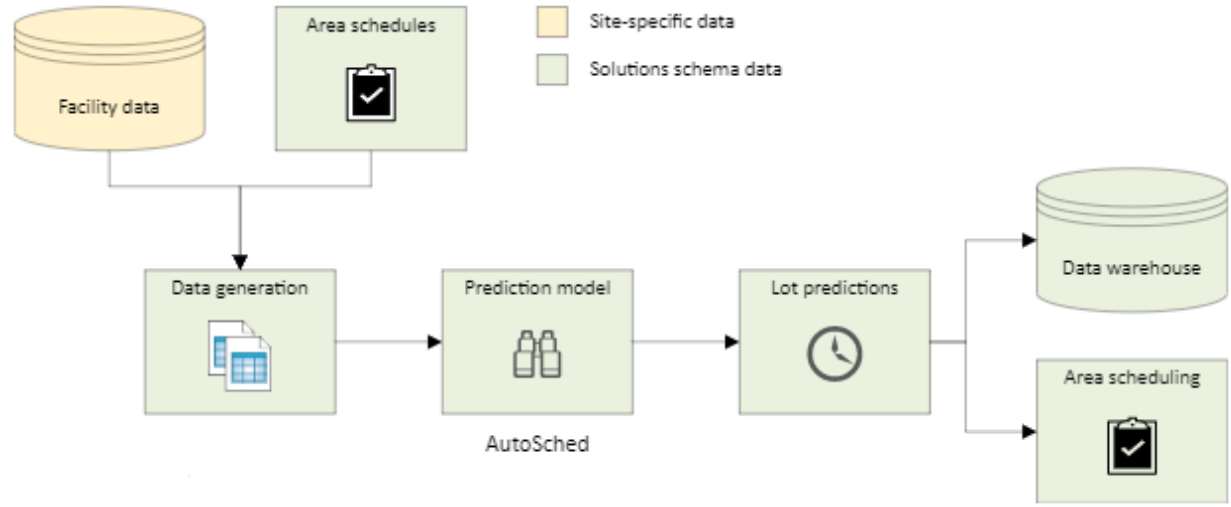

Figure 1: Prediction Flow

4 ADDITIONAL PREDICTION ENGINE BENEFITS

The prediction engine itself enables a greater level of modeling detail for equipment types along with modeling of actual capacity available for a given operation or step. Additional benefit analysis using the prediction engine capability includes determining optimal preventive maintenance schedules for equipment along with the ability to perform capacity planning analysis and determine the impact of anticipated changes in product ramp or introduction.

5 RESULTS

The company has successfully deployed the prediction engine and is running lithography and chamber area schedulers. Deployment results in a throughput performance gain in an automated low cost of ownership solution. The prediction engine is able to keep up to date with demands from current production changes and area scheduler optimization model execution. Additional areas of improvement have been identified and are planned. Wets-Diffusion area scheduling is in the final acceptance stage.