Tool Utilisation Optimisation of Semiconductor Manufacturing

NUS National University of Singapore

DEPARTMENT OF INDUSTRIAL SYSTEMS ENGINEERING AND MANAGEMENT

IE3100M/IE3100R SYSTEMS DESIGN PROJECT
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Micron

INTRODUCTION

PROBLEM DEFINITION AND OBJECTIVE:

Tools utilisation is a key component affecting the throughput of the tool, in turn affecting the efficiency of capital investment for tool purchase. As the test facility is transitioning from manual loading to Automated Material Handling System (AMHS), tool idling time is expected to be reduced. With that, the tool design also plays an important part in how effectively the tools can make use of the automated system. The project aims to analyse the ideal number of load ports for each probe tool type considering the utilisation of the tester, space, wait time, and the number of Front Opening Universal Pods (FOUP) processed.

SOLUTION REQUIREMENT:

1. To focus on the modelling of the test facility and the potential efficiency improvements that can be achieved by changing the number of load ports.
2. To give insight into how tool utilisation is improved by considering factors such as space, cost-benefit and time efficiency
3. Take into account all the workstations and product types, and their specific order and timings of operation in the test facility to ensure an accurate and functional result.

KEY SKILL SETS:

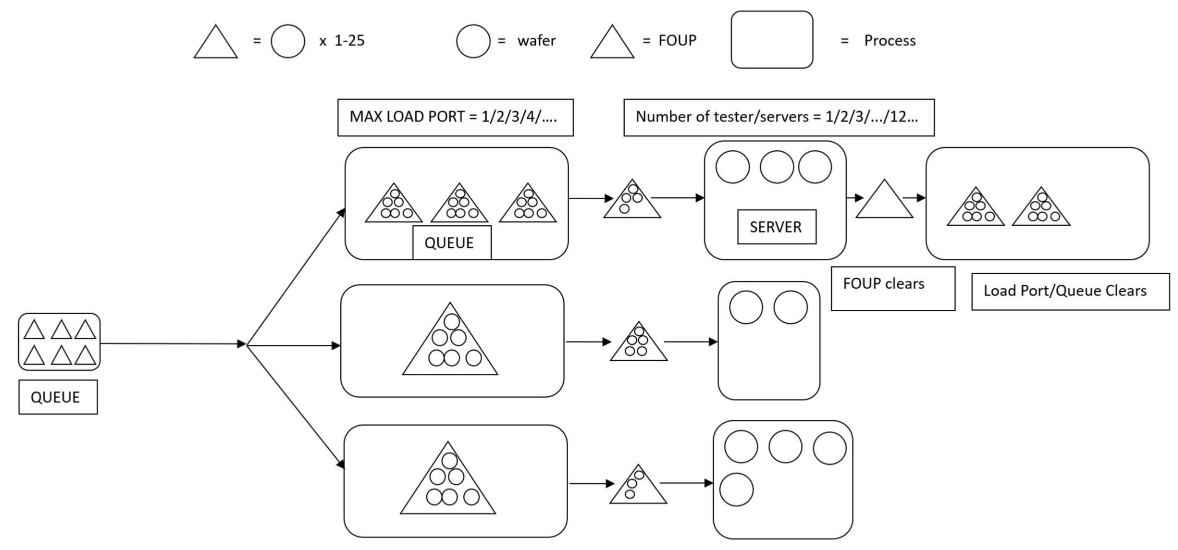
- Python & FlexSim
- Data Processing
- Systems Thinking
- Simulation
- Project Management

METHODOLOGY

APPROACH:

We build the simulation by using the approach of a Queueing System. The test facility comprises several types of machines, and there are numerous individual machines of each type. Each machine can have a different configuration of load ports and testers, and therefore a different testing capacity

The test facility works based on individual FOUPs that travel from machine to machine to get tested. In the figure, the main queue holds the FOUPs ready and waiting to be processed. This main queue then splits into 3 individual queues to enter one of the individual machines. The FOUPs can be split into any of the 3 individual queues based on availability as they are all the same machine type. The load ports hold the FOUPs while the wafers inside the FOUP are tested individually by the machine testers.



Each machine can have a different number of testers, in this scenario the individual machines have 3, 2, and 4 testers respectively. Once all the wafers in the FOUP are done getting tested, the FOUP is removed from the load port and the queue becomes empty to accept another FOUP from the main queue.

DATA PROCESSING:

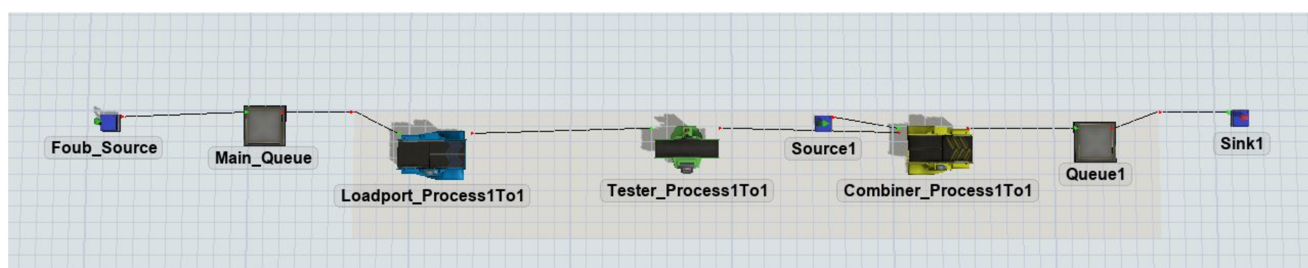
- Past data for the test facility from the company SQL database was used to derive distributions for the inter arrival time and processing time for each step and each product type.
- Python Scipy library was used and the data was fitted for normal, exponential, logistic, lognorm, triangular, beta and gamma distributions.
- Interarrival time was derived through the calculation of the difference between each subsequent time of a FOUP arrival for each step.
- Processing time was calculated for each wafer for each step and product type by the difference in the track in and track out time in the dataset

MODEL:

Base model is utilizing Flexsim Software and is being developed upon a single machine. The number of machine will be replicated by the set parameter according to the actual scenario in Micron's Manufacturing site. The experimenter will take into account the existing parameters and apply it into the performance measures that have been set. The experimenter will run for 1 week worth of wafer manufacturing

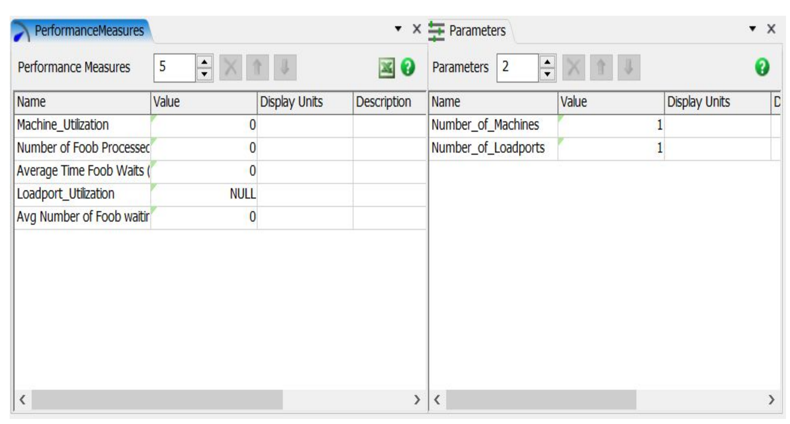
Parameters:

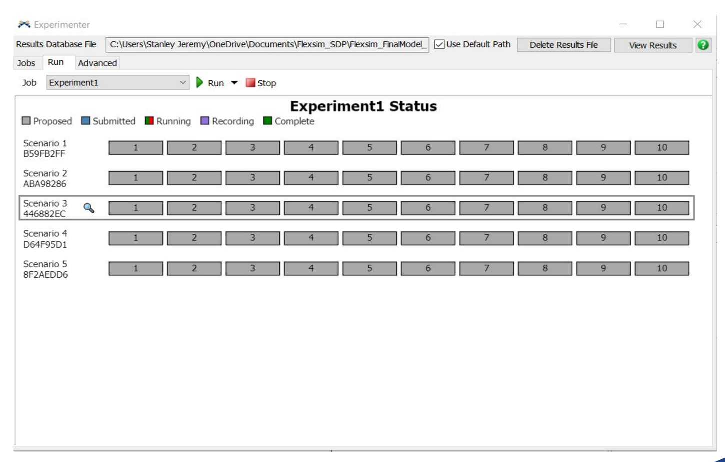
- Number of Machines
- Number of Loadports (in each machine)



Key Performance Measures

- Number of Foups produced per week
- Tester Utilization
- Load Port Utilization

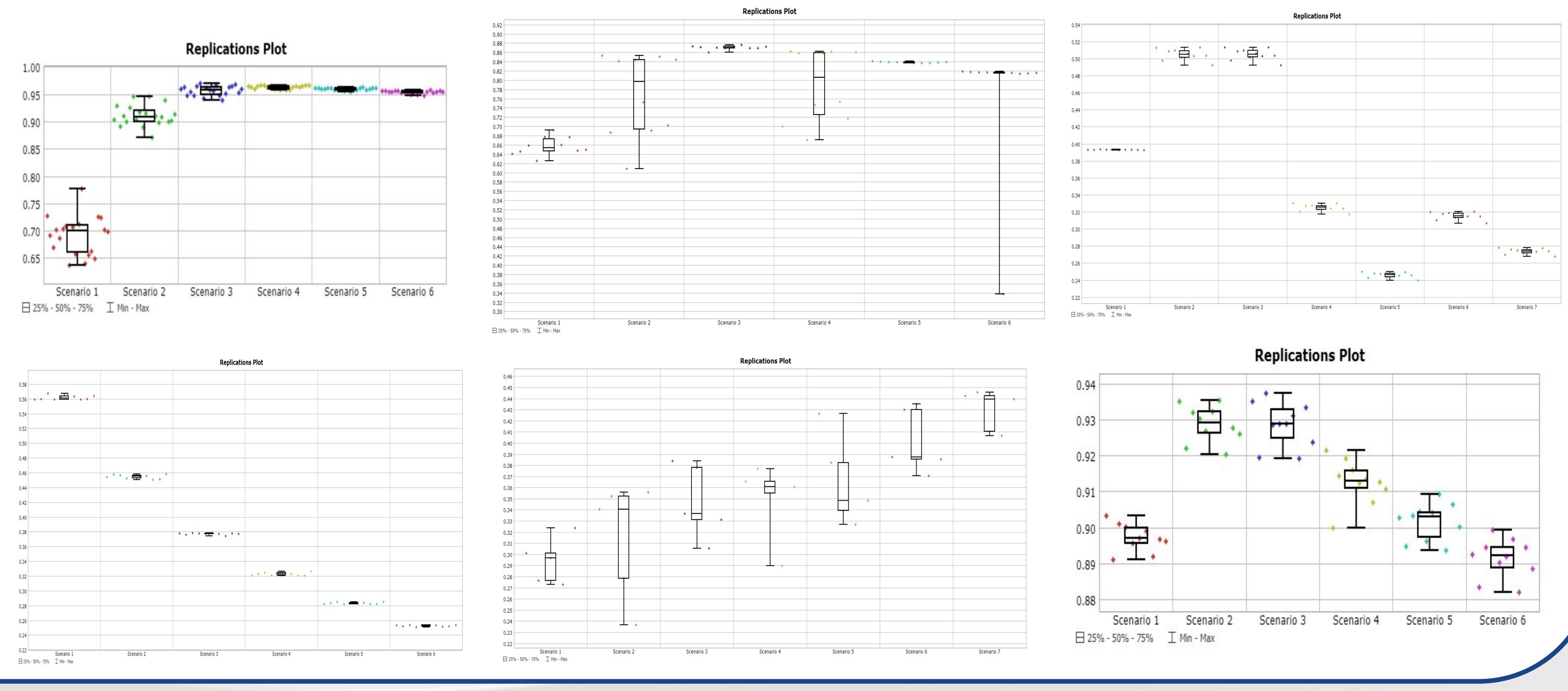




RESULTS

The experimenter will generate box-and-plot graphs as well as summary tables based on the key performance measures. This will highlight the results for 6 different scenarios tested for increasing number of loadports. Results generated will highlight the best machine configuration for each step/processes

Step Number	Ideal number of load ports	Ratio of Tester:Load port
1	3	1:3
2	2	1:2
3	1	1:1
4	2	1:2
5	6	1:6
6	2	1:2
7	3	1:3



FUTURE DIRECTIONS

1. Integrate the different processes into one model to better reflect the current fabrication line as a whole.
2. Refining the distribution as more data becomes available in the future, with more emphasis on the currently constructed AMHS in the fabrication site to identify further ways the manufacturing process can be optimised.

CONCLUSION

The use of simulation tools like FlexSim can be highly beneficial in predicting the optimal number of load ports in a fabrication plant. By building a virtual model, defining input parameters and performance metrics, we ran the simulation to analyse the results and make informed recommendations. By optimising load port configurations, we improved their overall productivity and efficiency.