Department of Industrial and Systems Engineering
IE3100 System Design Project

Lot Size Optimization

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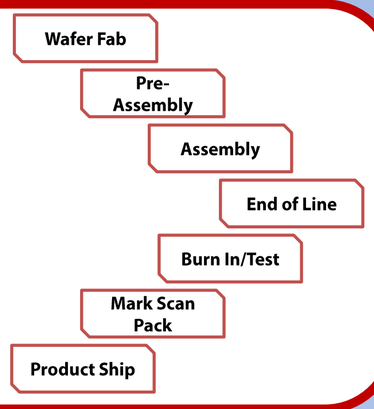
Problem Definition

Company Background

- Regional headquarter for backend manufacturing
- Focus on production efficiency improvements via lean manufacturing

Problem Definition

- Optimal lot sizing selection
- Optimal operation strategy for the mix of products



Methodology

Define → **Measure** → **Analyze** → **Improve** → **Control**

Define	Measure	Analyze	Improve	Control
Clarify problem & requirement	Analyze current process & refine scope	Factors for improvement of process	Find & Verify solutions	Ensure consistent improvement

OR Model

Real Situation

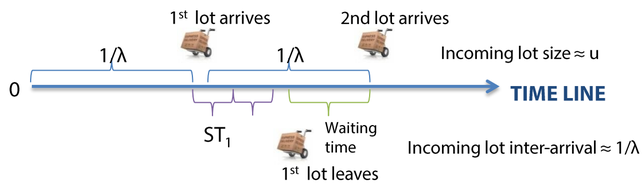
The backend production line is a multi-staged process which completed wafers come in from upstream plants. The following procedures are carried out:

- Incoming lots are prepared and arranged for the testing process.
- The lots undergo a series of tests with machines.
- Lots after the testing process undergo burn-in in the ovens.
- The lots are then brought through marking, scanning and packing.
- Dry Packaging to seal moisture out is done.
- Lot completed and preparation for shipment.

Math Model

Objective Function:

Minimize $Z = \sum_{j=1}^{M} Z_j$



Where $Z_j = T_{j-1} + \sum_{i=2}^{N}(T_{(j-1)i} - T_{j(i-1)}) + (D/X) * ST_j$

$T_{11} = (X/u) * (1/\lambda) + ST_1 + Y_1(X)$

ST_j: *the set − up time for process j*

Y_j: *the set − up time for process j*

T_{ji}: *the time when the* i^{th} *lot leave process j*

S.T. $X \leq$ *oven capacity*

$X \leq$ *human operator capacity*

$CT \leq$ *required minimum cycle time*

Limitations of OR

- Only lot size for single product in dedicated production set-up is determined.
- The solution is not applicable for non-dedicated set-ups.
- Further exploration is needed with simulation.

Simulation Model

Model Overview

Model Formulation → Model Validation → Scenario Analysis

Single Product Scenario

Product PG-LQFP-176

Input Data

- The arrival quantity of this product follows N~ (1197.278, 250.99), arrival frequency has a mean of 32.5 per day
- The test period is set at 31 days

Tests

- 10 different tests with various test time per unit (J750, Test 1 – 0.013 mins/unit; YRPT Oven – 750 mins/batch)
- Machine MTTF and MTTR is considered in the simulation run

Assumptions

- The test line is running for 24 hours
- There is only one machine each for different tests (except for oven)
- There is no mix of different products

Multiple Products Scenario

- **Non Dedicated Mode**

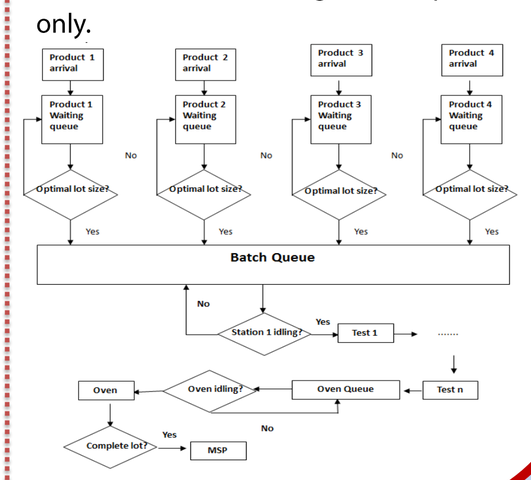
First come first serve for all products.

- **Partial Dedicated Mode**

High runner product has the priority to be processed first.

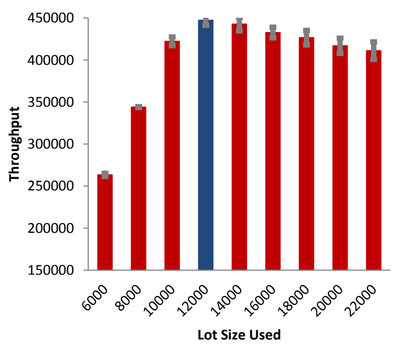
- **Fully Dedicated Mode**

Dedicate machines to high runner product only.



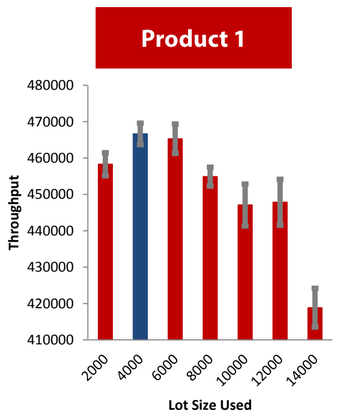
Result Analysis

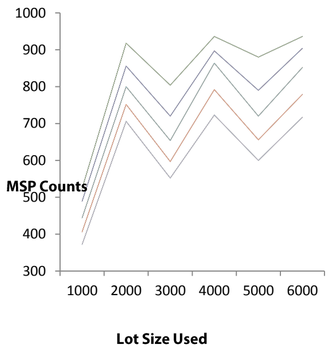
Analysis of Oven Variability



VS

Product 1





- Without consideration of oven variability
- Optimal lot size is **12000 units**
- **Is oven the bottleneck?**

- With consideration of oven variability
- Optimal lot size is **4000 units**

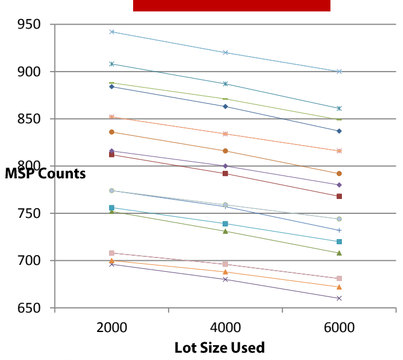
- Regardless of variability in arrival quantity or change-lot durations, multiples of oven capacity tend to yield higher throughputs

Sensitivity - Impact of Arrival Quantity/Change-Lot Time (single product)

I) In the base case, there is an optimal lot size for each product, which is a multiple of oven capacity and its threshold is determined by the arrival quantity and change-lot time

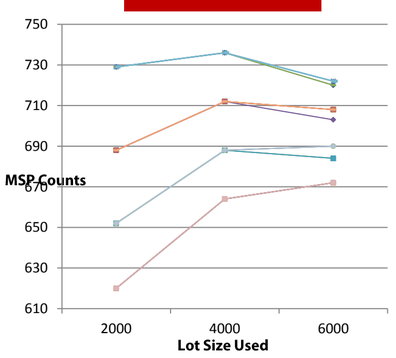
II) A larger optimal lot size is expected with higher arrival quantity and longer change-lot time

Product 2



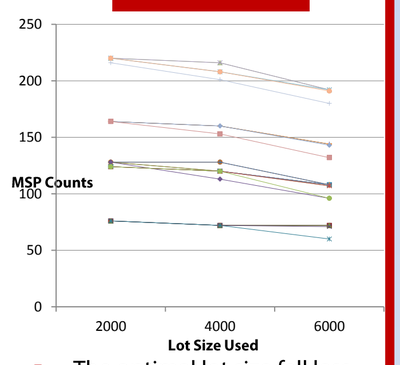
- Due to longer inter-arrival time, product 2's optimal lot size did not reach the threshold of change despite the increment in change-lot time

Product 3



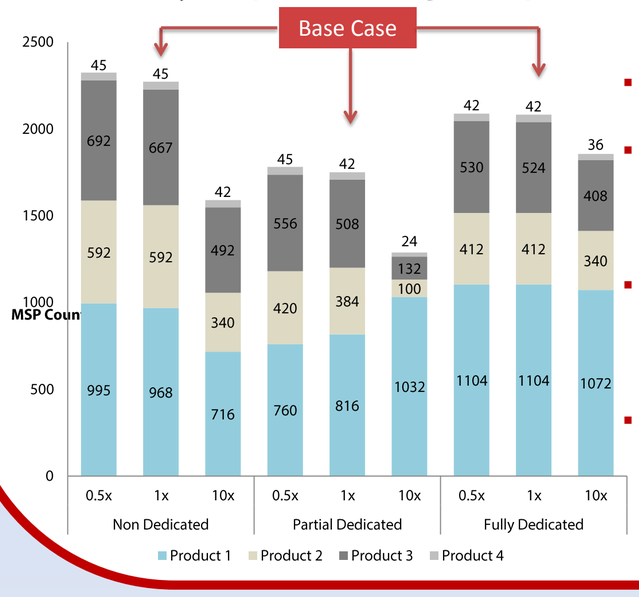
- The optimal lot size increased as predicted when the change-lot time and arrival quantity are increased

Product 4



- The optimal lot size fell less than 2000 units despite the increment in the change-lot time due to low arrival quantity

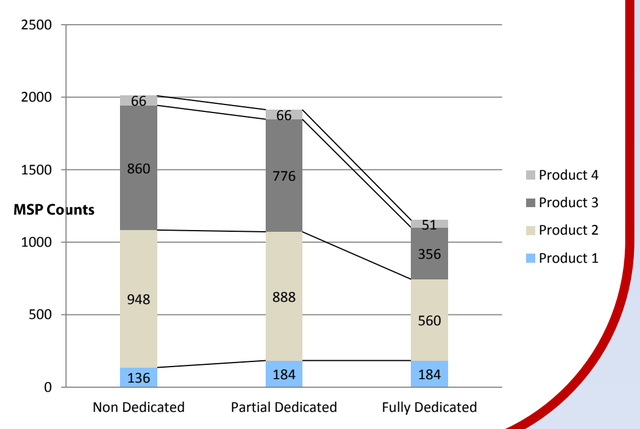
Sensitivity - Impact of Change Setup Time (multiple products)



- When the change setup time increases by 10 times, fully dedicated mode has the highest throughputs
- When the change setup time reduces by half, non dedicated mode is the most preferred followed by the fully dedicated mode due to the high volume of product 1
- For fully dedicated mode, when setup time increases, the throughput for product 1 remains almost constant while throughputs for product 2 and 3 decrease
- For non dedicated mode, when setup time increases, the throughputs put for all products decreases

Sensitivity - Impact of Priority Product Quantity (multiple products)

- The performance of partial dedicated mode improved significantly when the arrival quantity of priority product (product 1) was reduced
- The optimal operation strategy is highly dependent on the change setup time , arrival quantity and arrival interval of the products



Recommendations

Present

- A potential opportunity to standardize product lot size for operation for existing products

Short-run

- Coordination with sub-con parties to request for a more standard and stable arrival pattern, to cater for the optimal lot size identified and to reduce WIP for each product

Long-run

- For newly introduced products, a single product model can be used to search the optimal lot size. Then based on the product's arrival quantity and inter-arrival time, determined using multiple product model