OPTIMISATON OF AMHS USING SIMULATION

IE3100M Systems Design Project | Group 14
Department of Industrial Systems Engineering and Management
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Department Supervisor
Associate Professor Chen Nan
Micron Supervisors
Mr. Christian Indra Kusuma & Mr. Richie Tai
Team Members
Benjamin Tan |Huang Meiqi |Marina Tai | Samuel Chua | Shi Gaojian

BACKGROUND

- Micron's fabrication plants is currently using Automated Material Handling System (AMHS), a specialized system responsible for transporting the Front Opening Unified Pod (FOUP) around a fabrication plant.
- A FOUP is a specialized plastic container intended to hold plastic wafers in a secure manner and allows for the wafers to be transported from one workstation to another workstation for any form of processing or measurement.
- The purpose of AMHS is to reduce the manufacturing cycle time and improve the overall performance of the wafer fabrication process.

SKILLSETS

Simulation Modelling | Data Analysis | System Optimization

MOTIVATION

- Currently, Micron is unable to predict how unforeseen circumstances in the AMHS will affect the system's KPIs. Therefore, simulation is identified as a viable option to study the intrinsic behavior of the AMHS and evaluate the efficiency of AMHS within the fabrication plant.

OBJECTIVE

Primary
- Create a strong foundational simulation model that replicates the current AMHS, and evaluate the feasibility of the software for potential future development and in-depth analysis of the AMHS for operational improvements.

Secondary
- Identify congestion points in the system.
- Test for influential parameters through sensitivity analysis.

METHODOLOGY

PROBLEM ANALYSIS → SOFTWARE TESTING → DATA COLLECTION → MODEL FORMULATION → MODEL VALIDATION → RESULTS & RECOMMENDATION

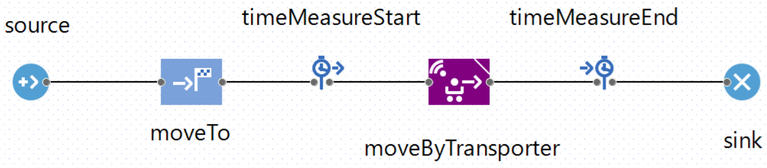
ASSUMPTIONS

- The dispatching rule of vehicles is nearest agent
- Vehicles set to take the shortest path
- Interarrival time of loads generated is constant
- Intra-bay structures are standardised
- Vehicles are distributed evenly throughout the facility

SOFTWARE TESTING

	Capacity	Interface	Complexity
Automod			✓
Arena	✓		
AnyLogic	✓	✓	✓

FLOW CHART



Source: Generates loads, assigns source and target nodes

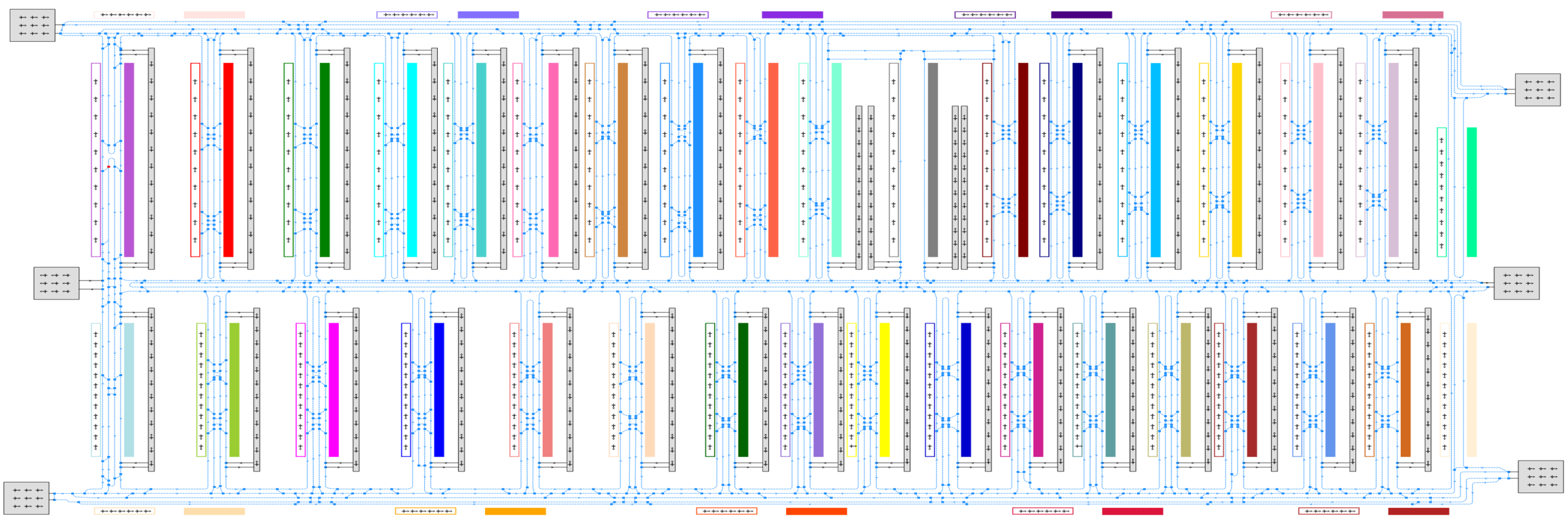
MoveTo: Shifts loads from dummy node to target node

MoveByTransporter: Transports loads from source to target using vehicle fleet

TimeMeasureStart & timeMeasureEnd: Measures cycle time (Duration that load stays in the system)

Sink: Loads exit the system

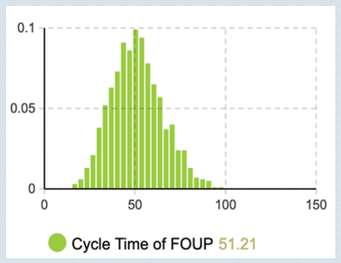
MODEL FORMULATION



BASE MODEL RESULTS

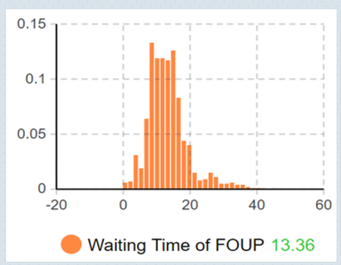
Key Performance Indicators

- Average FOUP cycle time: Measures the time taken for a FOUP to be delivered from its origin to its destination



CycleTimeDistr		
Count	2,671	
Mean	51.208	
Min	11.442	
Max	111.549	
Deviation	14.323	
Mean confidence	0.543	
Sum	136,776.134	
From	To	PDF(hits)
8.35	11.71	1
11.71	15.07	1
15.07	18.43	7

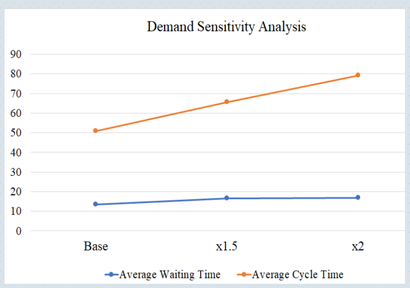
- Average FOUP waiting time: Measures the time from when the vehicle is activated to time the vehicle arrives to load the FOUP.

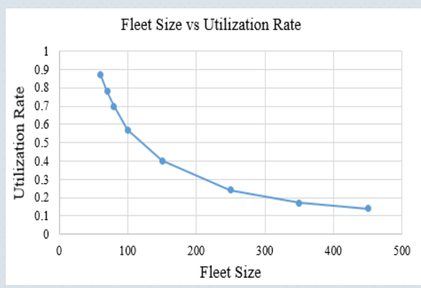


WaitingTimeDist		
Count	2,671	
Mean	13.361	
Min	0	
Max	47.368	
Deviation	6.246	
Mean confidence	0.237	
Sum	35,687.469	
From	To	PDF(hits)
-0.26	1.34	17
1.34	2.94	19
2.94	4.54	83

RESULT ANALYSIS

- The average cycle time is more sensitive to changes in demand levels
  - Increased demand leads to faster load generation in the system, resulting in greater vehicle movements.
  - Due to shortest path algorithm, with an increasing number of vehicles in the system, certain routes in the AMHS have higher utilisation rate.





- Utilisation rate is more sensitive when fleet size is small.
- If the utilisation rate is a benchmark for system's KPI, there is greater volatility in the system's KPI as vehicle size decreases.

LIMITATIONS

- Due to the complexity involved in building the simulation model, many assumptions were made to ease the process. Therefore, the KPIs obtained from simulation do not match the actual KPIs.
- Congestion may be present at nodes but due to software settings, the nodes have infinite capacity and congestion are harder to identify.

FUTURE IMPROVEMENTS

- Improve on the current route selection logic. Route costing can be implemented in place of the shortest path algorithm.
- Inclusion of storage locations
- Implement unique source creation rates for individual bays to have distinctive rates of load generation at different periods.