IE3100M Systems Design Project. Department of Industrial Systems Engineering and Management, AY2019/2020

A joint-effort by NUS and Infineon Singapore

AUTOMATED DECISION-MAKING IN SCHEDULING AND DISPATCHING

Project Description

Infineon Technologies AG specialises in manufacturing semiconductors, with many of its branches located globally, such as in Singapore. To stay ahead of competitors, improving operational efficiency is pertinent for each department in Infineon Singapore. In meeting this challenge, the Line Control department has introduced two optimisation tools: the Scheduling & Planning Optimisation Tool (SPOT) and Real-Time Dispatch (RTD).

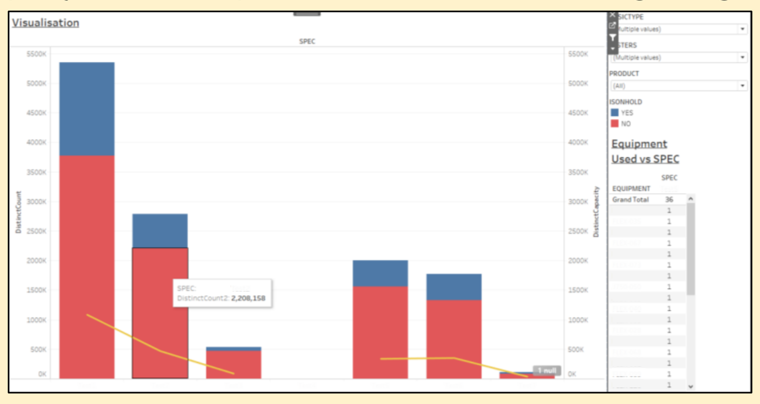
This project aims to further improve efficiency in Line Control, by streamlining the various decision-making processes, validating effectiveness of SPOT and simulating the effect of varying RTD dispatch rule priorities on Key Performance Indicators (KPIs).

Objectives

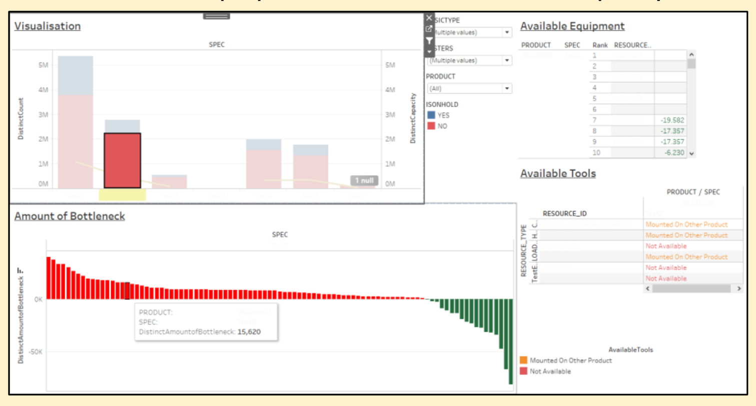
- **1.1** To develop a data visualisation platform for real-time updates of the Work-in-Process (WIP) quantity and capacity of all products
- **1.2** To identify bottlenecks in the system for analysis of gaps
- **1.3** To streamline decision-making processes for easing of bottlenecks
- **1.4** To validate the optimality of SPOT
- **2** To develop a simulation program or iterative calculation to generate measurable KPIs – Operational Equipment Efficiency (OEE), CLIP & Cycle Time Spread (CTS)

Methodology

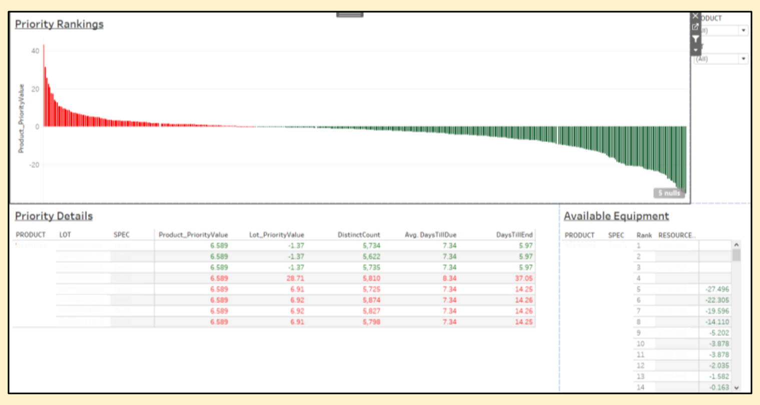
1.1 Tableau chosen for data visualisation to produce a summary of WIP and projected capacities for each testing stage



1.2 Bottlenecks identified by comparing capacities against WIP quantity, with available equipment and tools displayed



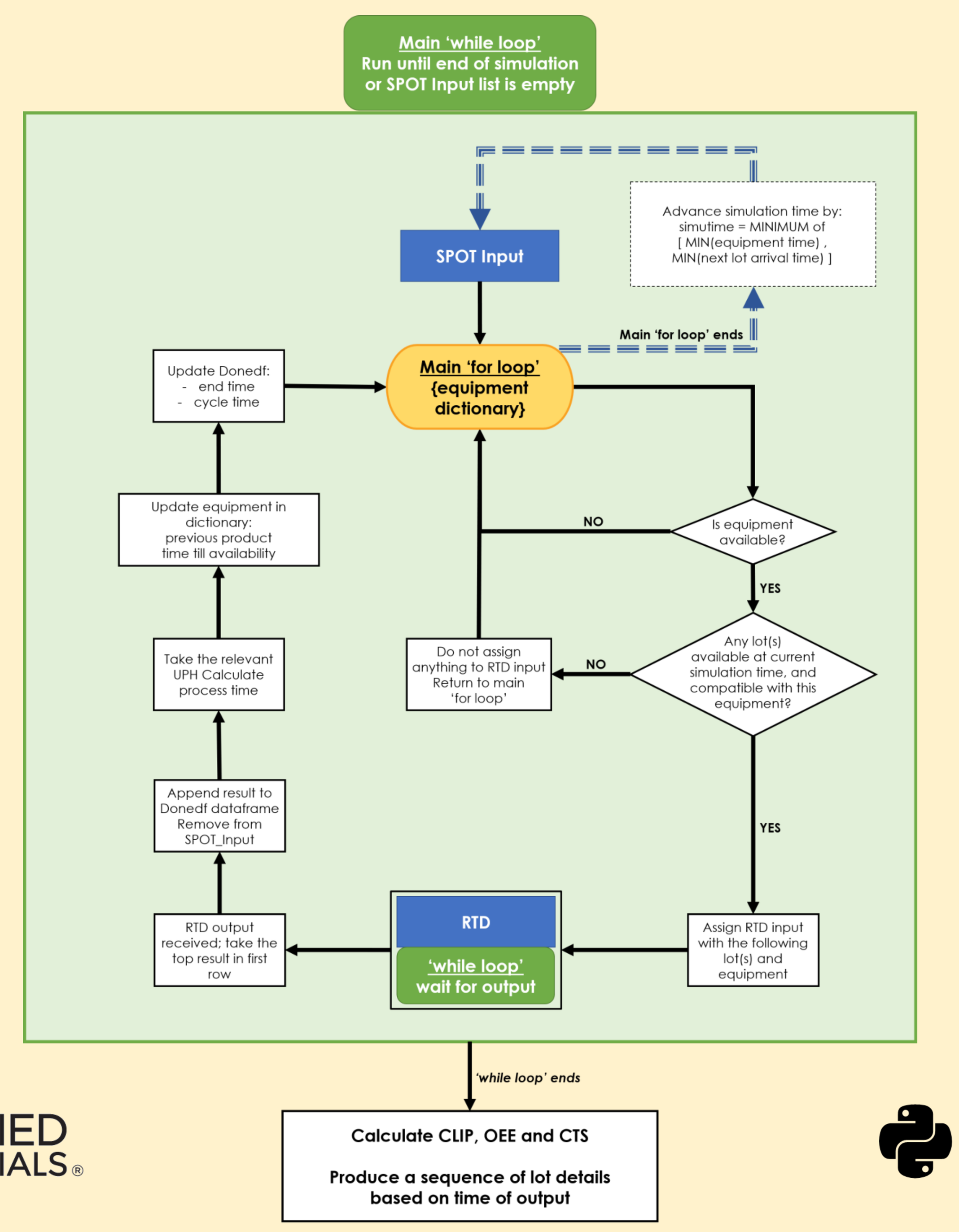
1.3 Lot and product priorities calculated by comparing the potential time taken to be cleared against the due date



1.4 Gantt chart of the planned schedule used as visual aid to easily read and to uncover instances of non-compliance

2 Applied Material's Advanced Productivity Family (APF) Tools is the main software in Line Control for extracting key data in real-time from multiple large data sources with no complicated programming required, and is the application used to run RTD. Linear and non-linear programming methods were considered for iterative calculations, but the team decided to adopt Python as the basis of the simulation program for RTD. This is because Python is the only language available in Line Control that is compatible with APF.

The team then applied systems-thinking skills and created a process-flow diagram in pseudocode, modifying it over time as the simulation program grew in its complication.



The logical flow would then be converted into a working prototype in which preliminary analysis would be done and feedback obtained. Lastly, serial design modifications were made to the prototypes based on the numerous feedback gathered from discussion with Infineon supervisors. This would allow the team to employ a comparative analysis against a simulation model of the testing line, and possibly include statistical analysis.

Analysis of Results

1

From the second and third Tableau visualisation models, it appears that SPOT is not very optimal as the priority score used to identify testing equipment for allocation is polarised, with several tall 'red' and 'green' bars indicating sub-optimal resource allocation by SPOT

The equipment usage seen on a day to day basis of the fourth visualisation model was contradictory to what Infineon Singapore had initially suggested, as the compliance rate was observed to be near 100%. This was plausibly due to:

- Data input from SPOT only contained a single equipment series (*ALPHA**), and would thus not be a good representative of the entire testing line
- Assuming truth for the model and Infineon Singapore's observation, then the compliance rate for other equipment series are much lower

2

OEE – total equipment uptime (measured in percentage)
Majority of the equipment have OEE around 80%, not meeting the desired OEE level set by Infineon. This suggests that the current RTD dispatch rules may be improved. Notably, more runs are required for this finding to be conclusive.

CLIP – demand fulfilment of testing of the testing line (measured in percentage)
CLIP for some products surpass 100%, suggesting more is produced than required by demand in that week. This shows a possibility of better allocation of resources to other products with low CLIP. It also shows that the dispatch rule does not give high priority to due date. Notably, this may be due to limited runs.

The Python simulation provides Infineon with the ability to forecast future performance of the testing line, allowing them sufficient time to make crucial decisions ahead of time.

Discussion

Improvements Needed

1

Analysis of the non-compliance situation can be expanded by including data from other types of equipment besides *ALPHA** series to the fourth Tableau visualisation model

Examine the optimality of SPOT by looking into the actual source code, which was actually a black box to the team and requires special authorised access

2

Automate the configuration of RTD dispatch rule priority input file, to determine the best RTD rule-setting based on KPIs

Use the true starting state of the system, rather than adopting the assumption of initialising all equipment to be available for production

Improving the runtime of the system by changing it from serial to parallel computing, so that processes can be run simultaneously. This will allow for more comprehensive runs that would increase the accuracy of simulation output,

Future Direction

1

Ensuring that the input data provided by Infineon is robust so that it can be more easily used for different purposes by Infineon

Expand the functionality of the visualisation models to handle other requirements which may arise in the future

2

Determine the best dispatch rule order by varying the RTD dispatch rule priority inputs, based on the simulated KPIs

Identify and implement methods such as Machine Learning or Artificial Intelligence, that taps on historical data for improve SPOT resource allocation

Key Skillset

Project Management

Programming

Data Visualisation

Simulation

Systems Thinking

Acknowledgements

Department Supervisors:
Professor Andrew Lim
Dr Bok Shung Hwee
Mr Ang Kang Soon
Mr Fang Jian Xin

Infineon Supervisors:
Mr Goh Jin Theak
Ms Ang Bao Jun
Ms Zhong Ning

Group Members:
Lee Wei Xiang
Samuel Tan Teik En
Tan Zhee Yong
Yeo Chong Han

*The name of the equipment series has been modified for data protection purposes.