Faculty of Manufacturing Engineering

MIXED-LOAD MACHINE UTILIZATION IMPROVEMENT AND TRANSFER BATCH SIZE OPTIMIZATION USING HYBRID SIMULATION APPROACH

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2014

DECLARATION

I declare that this thesis entitle "Mixed-Load Machine Utilization Improvement and Transfer Batch Size Optimization using Hybrid Simulation Approach" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not currently submitted in candidature of any other degree.

Signature : .....

Name : Hayati Mukti Asih

Date : June 3, 2014

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Science in Manufacturing Engineering.

Signature : .....

Name : Assoc. Prof. Dr. Chong Kuan Eng

Date : June 3, 2014

DEDICATION

To my beloved families:

My Husband, Mommy, Daddy, and Sister

ABSTRACT

Current technological development has increased the competitiveness in the manufacturing system, especially for the electronic industry. This research is based on case company in the automatic testing and label printing processes of a multinational hard disk drive (HDD) manufacturing system with the objective of improving the tester utilization while achieving the production target. The problem is complex as the testers are employed to simultaneously load multiple product families. Each product family has several models with different testing durations. In addition, apart from the high product mixes for each product family undergoes different process flow making the problem more complicated. The company has difficulty to achieve the targeted tester utilization of 96%, as the current utilization is 71.14%. As the problem is too complicated to be solved by an analytical method, a hybrid simulation approach was employed to solve the operation machine allocation and the transfer batch size problem. Firstly, the problem of mixed-load tester was formulated through a mathematical model. Then, a simulation model was designed and developed to evaluate the scenarios of the mixed-load tester configurations. After that, the multi criteria decision making techniques were employed to determine the best scenario. Finally, the transfer batch size was optimized to improve system WIP. The final proposed configuration successfully increased the tester utilization by 24.89% and reduced the number of testers by 37.77% for Tester A and by 27.27% for Tester B while improving the throughput by 6.88% compared to the current system. In addition, the transfer batch size was reduced from 120 units to 86 units and system WIP was successfully reduced by 6.43%.

ABSTRAK

Perkembangan teknologi semasa telah meningkatkan daya saing dalam sistem pembuatan, terutamanya bagi industri elektronik. Penyelidikan ini berasaskan kepada kes di syarikat yang melaksanakan pengujian automatik dan proses pencetakan label bagi sistem pembuatan multinasional cakera keras (HDD) dengan matlamat untuk memantapkan lagi penggunaan penguji sekaligus mencapai sasaran pengeluaran. Masalahnya kompleks kerana penguji digunakan untuk memuatkan jenis produk berganda pada masa yang sama. Setiap jenis produk mempunyai beberapa model dengan jangka masa ujian yang berbeza. Sebagai tambahan, selain daripada campuran-campuran produk yang tinggi setiap jenis produk menjalani aliran proses yang berbeza menyebabkan masalah yang menjadi lebih rumit. Oleh itu, syarikat itu sukar untuk mencapai penggunaan penguji itu kepada 96%, manakala sistem sedia ada adalah 71.14%.Kerana masalah itu terlalu rumit untuk diselesaikan dengan kaedah analitikal, pendekatan simulasi hibrid telah diambil untuk menangani peruntukan operasi ini pada mesin dan masalah pemindahan saiz kelompok. Pertama sekali, masalah penguji yang bercampur beban dirumuskan melalui model matematik. Kemudian, model simulasi direkabentuk dan dibangunkan bagi menilai senario konfigurasi penguji yang bercampur beban itu. Kemudian, pelbagai kriteria teknik membuat keputusan telah digunakan untuk menentukan senario yang terbaik. Akhir sekali, pemindahan saiz kelompok telah dioptimumkan untuk memperbaiki sistem WIP. Konfigurasi akhir yang dicadangkan berjaya meningkatkan penggunaan penguji sebanyak 24.89% dan mengurangkan bilangan penguji sebanyak 37.77% untuk Penguji A dan sekitar 27.27% untuk Penguji B masa yang sama memperbaiki daya pemprosesan sebanyak 6.88% berbanding dengan sistem semasa. Di samping itu, saiz kelompok pemindahan telah dikurangkan dari 120 unit kepada 86 unit dan sistem WIP telah berjaya dikurangkan sebanyak 6.43%.

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In the name of Allah, The Beneficent, The Merciful.

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LIST OF ABBREVIATIONS

AHP	Analytic Hierarchy Process
FIFO	First-in-First-out
HDA	Hard Disk Assembly
HDD	Hard Disk Drive
MCDM	Multi Criteria Decision Making
OM	Operation Management
PPC	Production Planning and Control
TBS	Transfer Batch Size
TH	Throughput
TOPSIS	Technique for Order Preference by Similarity to Ideal Solution
WIP	Work-in-Process

LIST OF PUBLICATION

1. International Journal

Hayati Mukti Asih and Chong Kuan Eng (2014). Throughput and Tester Utilization Improvement in the Hard Disk Drive Assembly Line using Hybrid Simulation Approach. *Advanced Science Letters*, Vol. 20, No. 02.

2. Proceeding

Hayati Mukti Asih and Chong Kuan Eng. Throughput and Tester Utilization Improvement in the Hard Disk Drive Assembly Line using Hybrid Simulation Approach. *The 2013 Annual International Conference on Advances Technology in Telecommunication, Broadcasting, and Satellite (TelSaTech)*. 02 – 03 August 2013, Jakarta, Indonesia.

CHAPTER 1

INTRODUCTION

1.1. Introduction

Current technological development has increased the competitiveness in the manufacturing system, especially for hard disk drive (HDD) industry. In addition, the companies are required to focus on the job allocation of every machine and transfer batch size issues due to the high production volumes and variety of products. In the real world, many uncertainties influence the performance of a production system. According to Ho (1989), these uncertainties are caused by operating variables (i.e. the uncertainty of production yield, lead time, quality, product development, etc.) and environmental factors (i.e. the uncertainty of demand and supply).

One of the essential performances of the production system is machine utilization. Improving the tester utilization will result in achieving the production target based on customer order. In addition, another way to achieve good production performance measure is the work-in-process (WIP). The system WIP is the amount of product waiting in the production system. It could be the raw material, in-progress product and finished product. Reducing the WIP level yields increase the throughput, reduces cycle time and reduces cost as well.

Allocating jobs with stochastic input parameters, high product mixes and long production process time make it difficult to investigate the system performance through analytical methodology. This research, which is based on a case study of an HDD company, uses the hybrid simulation approach to solve the mixed-load tester and transfer batch size

problems. The mixed-load tester problem is the ability of a tester to simultaneously load multiple product families.

1.2. Company Background

This research is based on a case study of a back-end process of an HDD manufacturing system located in Petaling Jaya, Malaysia. The Backend process is a testing and inspection process after the completion of a one piece flow of Hard Disc Assembly (HDA) at the Cleanroom. The process flow in the assembly line is presented in Figure 1.1.

In these processes, there are two types of product produced in this company are 2.5" HDD and 3.5" HDD. There are more than twenty product families that are produced for both product types whereas each product family has different process flows, different production volumes and different testing process. Hence, this makes the HDD company more complex.

This research focuses on the automatic testing and label printing processes. The layout is shown in Figure 1.2. In the automatic testing process, there are two stages, i.e. Tester A and Tester B. It consists of seven lines for Tester A and three lines for Tester B. The feeder is the one who distributes the amount of drives from the buffer before automatic testing process to the small buffer which is close to each tester, then takes the tested drive to the next stage. A feeder is responsible for handling a line. Then, an operator loads and unloads drives to testers. On the other hand, in label printing process, the duty of the operator is to print the label on each drive and the feeder is to distribute the drives to each small buffer close to the label printing machine.

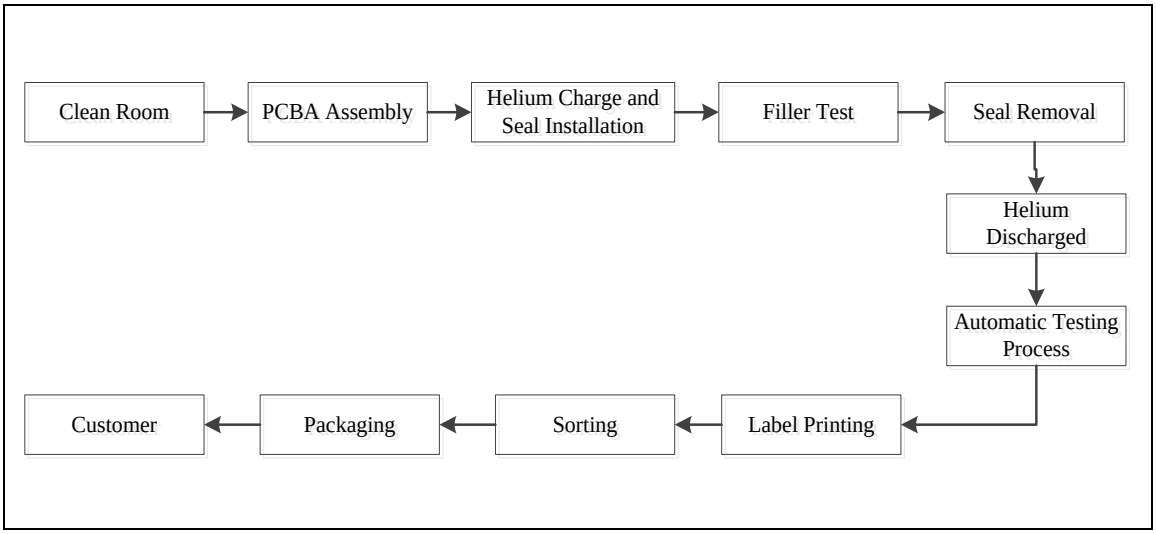

Figure 1.1 General Process Flow Diagram

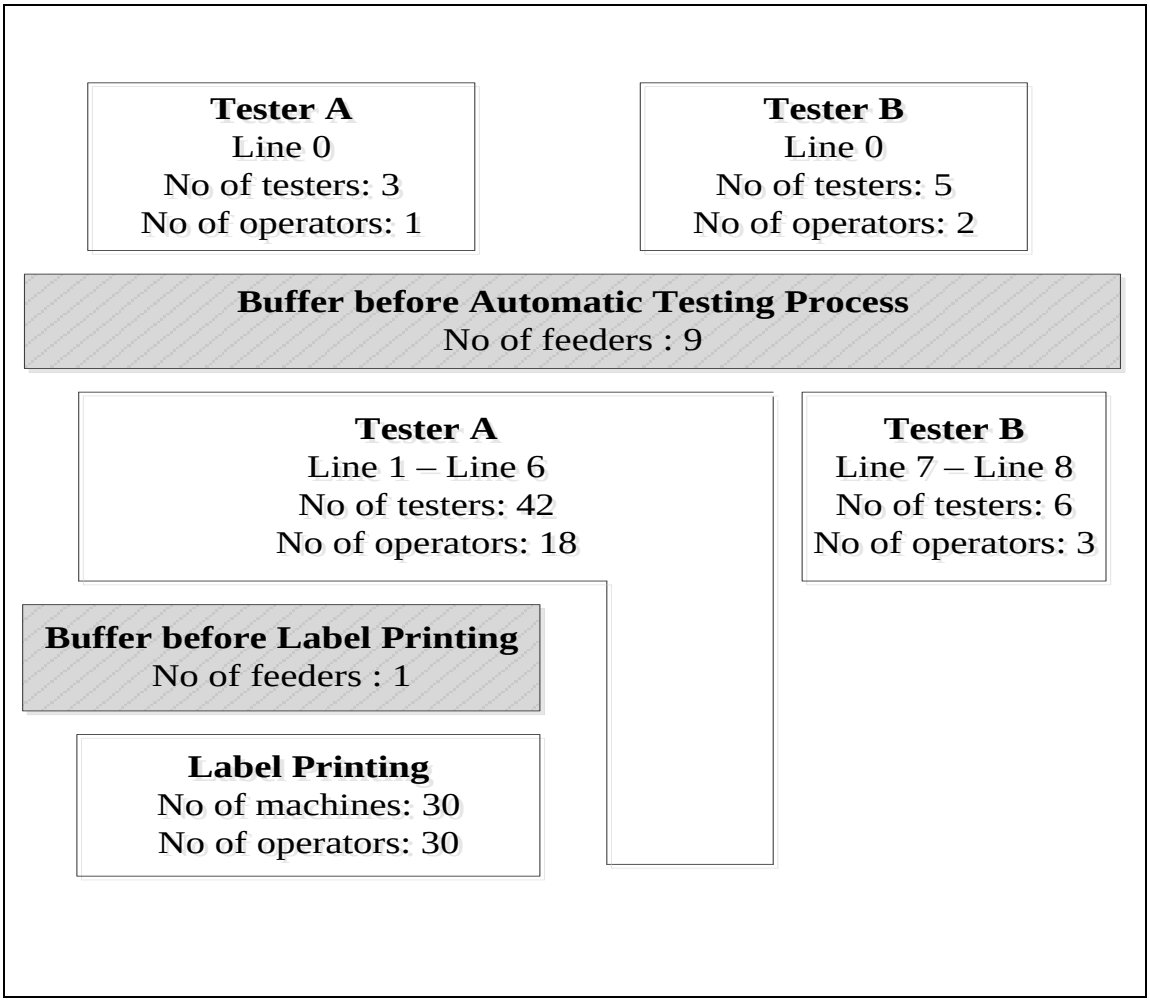

Figure 1.2 Layout of Automatic Testing and Label Printing Processes

1.3. Problem Statement

The observations of the production process and from the discussions with the managers, IE planner, plant supervisors and production line associates found that the characteristics of the shop floor are complex. The automatic testers are employed have almost three thousands slots that able to load multiple product families, simultaneously. Moreover, there are more than fifteen models in all product families with different testing durations. In addition, to the high product varieties, each product family undergoes different production process flow making the problem more complicated.

Therefore, the company is difficult to achieve the target of average tester utilization as 96%. While, the current system is 71.14% for 35 days. Figure 1.3 presents the gaps of the average tester utilization between the current system and the company`s target.

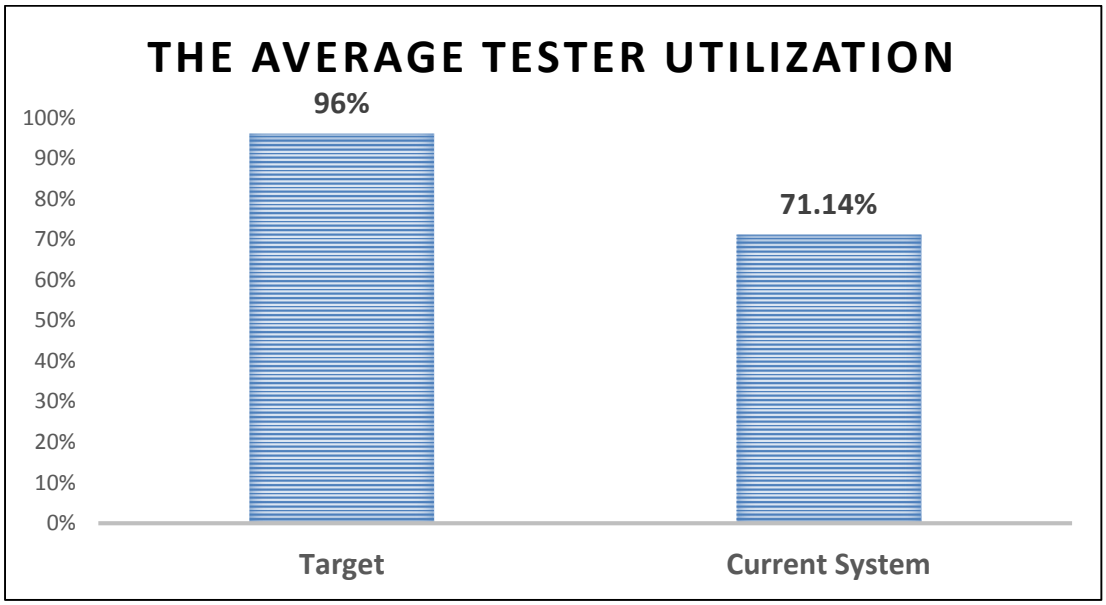

Figure 1.3 Average Tester Utilization: Current System versus Target

Because of the problem considering the uncertainties in production system, the analytical method is hard solving the problem alone (Robinson, 2004). Hence, the