INTEGRATION OF SMED AND TRIZ IN IMPROVING PRODUCTIVITY AT SEMICONDUCTOR INDUSTRY

KARTIK SREEDHARAAN KUMARESAN

UNIVERSITI TEKNOLOGI MALAYSIA

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A project report submitted in fulfillment of the
requirements for the award of the degree of
Master of Engineering (Industrial Engineering)

Faculty of Mechanical Engineering
Universiti Teknologi Malaysia

MAY 2011

In dedication to my beloved parents and wife

ACKNOWLEDGEMENT

My sincere appreciation and thanks to my supervisor Assoc. Prof. Dr. Muhamad Zameri b. Mat Saman for his supervision, constructive critics and the continuous guidance to furnish this project paper to an accepted quality.

I am also indebted to my sponsor Intel Technology Sdn. Bhd. whom has supported me financially throughout my tenure as a post graduate student. Also would like to extend my appreciation to Mr. Ismail Ishak and Mr. TJ Yeoh from Intel KMCO, who provided technical assistance at various occasions throughout this project. Without their continued support and interest, this thesis would not have been the same as presented here.

I would take this opportunity also to recognize my parents, wife, family members and friends for their unconditional love and support.

Last but not least, none of this would be possible without the blessing and grace of the Almighty God *'Anbe Sivam'*.

ABSTRACT

A case study on a test handler's changeover process was conducted in a semiconductor organization (Intel Technology Sdn. Bhd.). The test handler being a constraint operation in the production supports the testing of two of the mainstream chipset products. Though the test handler is capable to support multiple chipset products but due to the equipment configuration complexity, the changeover process today requires an average 4 hours to fully complete. The long changeover duration degrades the overall productivity especially inability to meet customer demand timely, lower utilization and rising cost issues. These identified issues are potential factors that could impact the sustainability of the organization in long run. This case study focuses on improving the changeover process using techniques from Single Minute Exchange of Die (SMED) and Theory of Inventive Problem Solving (TRIZ). Both the techniques have individual strengths and weakness and thus the focus will be to integrate them to complement each other to enhance the changeover process duration further. Problems in the current process like non standard practices, complex hardware setup and waste activities that plagued today are process were identified and categorized accordingly. Later, appropriate techniques from SMED and TRIZ were proposed to counter these issues systematically. SMED will be used mostly for task simplification while TRIZ will be used for hardware part redesigns and overall process optimization. The end of mind of this study is to achieve a lean and optimized changeover process that can be performed below 30 minutes with no safety, quality or output concerns.

ABSTRAK

Kajian kes ini bertumpu amnya pada pengubahsuaian mesin di Intel Technology Sdn. Bhd yang merupakan pemgeluar cip komputer terbesar di dunia. Mesin yang digunakan di operasi pemeriksaan cip silikon secara automatik ini mampu mengendali pelbagai jenis cip tetapi memerlukan pengubahsuaian tertentu. Proses pengubahsuaian mesin ini boleh memakan masa sehingga 4 jam untuk disiapkan sebelum digunakan balik untuk operasi. Disebabkan ini, organisasi ini mengalami kemerosotan produktiviti and juga kerugian kos-kos lain. Untuk mengatasi masalah ini, teknik-teknik daripada SMED and TRIZ diperkenalkan untuk menyelesaikan isu –isu seperti ketidakselarasan aktiviti dan penukaran alat ganti yang kompleks. Teknik SMED and TRIZ dikaji secara teliti sebelum dicadangkan untuk penyelesaian. Teknik-teknik SMED banyak digunakan untuk mempermudahkan activiti kerja dan teknik-teknik TRIZ banyak berguna untuk mereka bentuk alat ganti yang lebih mudah dan efiksyen untuk ditukar ganti. Cadangan-cadangan ini setelah dilaksanakan dapat membantu mengurangkan masa pengubahsuaian daripada 4 jam kepada 30 minit dengan tiada sebarang masalah kualiti, keselamatan ataupun pengeluaran.

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LIST OF ABBREVIATIONS

ABBREVIATIONS	FULL NAME
AEPT	Automated Equipment Performance Tracking
ATE	Assembly Test Equipment
GU	Goal Utilization
HMLV	High Mix Low Volume
MA	Machine Availability
NA	Not Available
NVA	Non Value Added
PM	Preventive Maintanence
SDT	Schedule Downtime
SPEC	Specifications
SEMI E10	Semiconductor Equipment and Materials International (E10 is spec)
SMED	Single Minute Exchange of Die
TIU	Test Interface Unit
TP	Test Program
TRIZ	Theory of Inventive Problem Solving
USDT	Unscheduled Downtime
VA	Value Added

CHAPTER 1

INTRODUCTION

1.1 Overview

This chapter describes a high-level overview of this project. This includes the background of the project, problem statement, objective, scopes and the lastly significance of this project.

1.2 Background of Project

The ever-growing technological envelope and the shrinking of product life cycle have ultimately changed the overall face of today's global economy where trends are more volatile and impulsive with end-customers are more vivid in their choices and selection of products. The 'ripple' of these effects has strongly influenced in the semiconductor industries especially manufactures supporting High Mix Low Volume (HMLV) products. It is well noted that the number of transistors that can be placed inexpensively on an integrated circuit has doubled approximately every two years (Gordon Moore, 1965) which precisely describes a driving force of technological and social change in the late 20th and early 21st centuries and the trend has continued for more than half a century and is not expected to stop until 2015 or later. This has directly impacted the once flamboyant semiconductor industries which are now facing competitive pressures to meet the ever-changing demand from end customer and at the same time the challenge in reducing the overall operation cost.

Some 3 years ago, when Intel's Kulim Microprocessor and Chipset Operations (KMCO) mega-factory was erected as the biggest offshore facilities (was then taken over by the mega factory in Vietnam in 2nd Quarter 2010) and ramped-up aggressively for HMLV manufacturing (include assembly and testing), there were 2 main mounting challenges for the factory was;

i. To make a breakthrough in the factory process cycle time (time taken to manufacture a product from start of assembly to finish product ship out)
ii. To demonstrate a low cost competitive advantage especially when compared against Internal competitors (other Intel factories i.e. Penang, China, Costa Rica and US) and external competitors whom are mostly EMS or other sub-contracted factories

The above 2 challenges are linked together by one similar gating issue which is the conservative or the traditional manufacturing flow which focuses on batch-based production that in return produce large inventory build-ups, high storage cost and overall lower equipment utilization. This manufacturing method opposes exactly the concept of Lean Manufacturing which dictates on identifying and eliminating those waste or Non Value Added (NVA) activities in accordance to achieve optimum performance. Lean advocates for continuous flow and manufacturing flexibility of readily adapting to the market shifts (Anthony Inman, 2010). The ability and competency to be flexible is much easier to be said than done as the complexity to design such facility could be both costly and sophisticated especially on long term sustaining.

This project will fully focus on the case study of reducing the changeover time for an Automated Testing Equipment (ATE) called the 'Extreme Test Handler' in a semiconductor industry by integrating 2 well known problem solving methodologies; the Single Minute Exchange of Die (SMED) techniques together with the Theory of Inventive Problem Solving (TRIZ) principals.

1.3 Problem Statement and Justification

Today, the non flexible factory environment practices batch build of products and equipment dedication policy at the Test operation area due the long hours of non-optimized changeover process for the Test Handler which in result causes low equipment utilization, high inventory accumulation, higher cost per unit and the rising cost to purchase new capital equipments.

1.4 Objective

The objective of the project is to reduce the changeover duration for a test handler from a current 4.0 hours to 0.5 hours by integrating SMED techniques and TRIZ principals.

1.5 Scopes

The scopes of this project will cover as below:

i. Only techniques from SMED and TRIZ will be used. All the TRIZ are based only from the ‘Principal’ tools
ii. The study is limited only to the chipset products codenamed ‘Nebula Peak’ and ‘Nexus Peak’
iii. The focus area is the Test operation of the company where the focused equipment M4542AD Dynamic Test Handler (Extreme Handler)

1.6 Significance of Study

The highlights of this project are as below:

i. Changeovers or conversion for test equipments such as the Test Handlers are rarely studied or practiced upon compared to other assembly equipments such press, lathe or even conveyor based equipments. This could be due to fact that these types of test equipments are only commonly found at high end semiconductor industries with structural and functional die testing capabilities. Also to note is that this type of equipment are more complex and sophisticated technically to change or redesign.

ii. This project explores the opportunity to apply the SMED techniques to perform changeover for the Test Handler and further enhance the shortcoming of the prior techniques by integrating them with TRIZ principals.

1.7 Thesis Structure

This thesis consists of 7 chapters. Chapter 1 is the introduction of the project with background, problem statements, objective, scopes and the significance of the study. Chapter 2 presents the literature review on Lean manufacturing, rapid changeover, Single Minute Exchange of Die (SMED) and Theory of Inventive Problem Solving (TRIZ) which also consist the critical analysis of each techniques. Chapter 3 is basically the detail of the methodologies used throughout the project. Chapter 4 focuses on the problem identification in the case study where both qualitative and quantitative data collected are presented. Chapter 5 shows the counter measure proposals with respect to the SMED and TRIZ techniques. Chapter 6 is where the end results are presented together critical appraisals and future study recommendations. Chapter 7 is the conclusion and summary of this project.

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