

**REDUCTION OF DOWNTIME OF THE DURVILLE
DIE CASTING MACHINE AT ENKEI (M) SDN. BHD.
MAC1 PRODUCTION PLANT LINE A, USING TOTAL
PRODUCTIVE MAINTENANCE (TPM) AND
CONDITION-BASED MAINTENANCE (CBM)
APPROACH.**

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APPROVAL

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January 2017

DECLARATION

I, the undersigned, hereby declare that this report is my own independent work except as specified in the references and acknowledgements. I have not committed plagiarism in the accomplishment of this work, nor have I falsified and/or invented the data in my work. I am aware of the University regulations on Plagiarism. I accept the academic penalties that may be imposed for any violation.

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ABSTRACT

Downtime is one of the major hazards confronting the manufacturing industry today. It accounts for majority of the loss and waste incurred in production. When unplanned breakdown or unexpected failure happens due to equipment failure, whole production line stops and production automatically stops. Therefore it would be expensive to bring the production system running condition under emergency situation (Kotwal, Dhami, & Singh, 2015). Hence industries have a growing interest in new methods for maintenance and health condition assessment of machinery. Two of such methods, which this project explored, are Total Productive Maintenance (TPM) and Condition-Based Maintenance (CBM).

Enkei (M) Sdn. Bhd. is a multinational company headquartered in Hamamatsu City, Shizuoka Pref, Japan. It is a subsidiary of the Enkei Corporation established on 5 October 1950. The company is one of the world's largest high quality Aluminum Wheels manufacturers. Its products include aluminum wheel for automobile & motorcycle, and various aluminum casting parts. Enkei custom wheels deliver the latest in wheel designs, composite alloy technology such as, casting/forged processes, rigid testing that must pass stringent JGTC Standards and unsurpassed manufacturing facilities.

Despite the lean manufacturing practices adopted by Enkei and its rigorous Kaizen operations, one of the greatest wastes in its manufacturing plant is down time. Table 1 shows Down Time Ratio (DTR) of one of its plants (MAC1). Hence, the focus of this project is to reduce downtime by 20% for the casting section of the MAC 1 plant, conducting a pilot study on the Line A Durville Die casting machine. And to do this, the two methods (TPM & CBM) were studied; key strengths were drawn from each of them and combined into a new framework of methodology developed to solve this problem.

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Lastly, I thank my parents, Mr and Mrs Godwin Nelson, for the sacrifices they have made, and the support they have offered me in obtaining a good education which empowers. And ultimately, my thanks to Almighty God for the privilege of life and strength, wisdom and intellect to be where I am today.

DEDICATION

*This thesis is dedicated to my parents,
Mr. Godwin Nelson and Mrs. Mary Nelson.*

This work is for you.

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LIST OF ABBREVIATIONS

DTR	Down Time Ratio
CNC	Computerized Numerical Control
MAC	Most Advanced Control
TPM	Total Productive Maintenance
CBM	Condition-Based Maintenance
VSM	Value Stream Map/Mapping
KPI	Key Performance Indicator
TPS	Toyota Production System
CMMS	Computerized Maintenance Management Software
MTBF	Mean Time between Failure
MTTR	Mean Time To Repair
CS	Cumulative Scores of criticality
CN	Cumulative Number of equipment

NOMENCLATURE

<i>Symbol</i>	<i>Definition</i>
P	Probability of failure of equipment
P_t	Production loss in fraction
T_m	Mean time to repair
R_s	Mean cost of repairs
h	Criticality level
$<$	Less than
\geq	Greater than or equal to

CHAPTER 1

INTRODUCTION

1.1. Background

The Durville die casting machine is used by Enkei (M) Sdn. Bhd. in a hybrid combination with MAT technology to produce high performance light weight, stiff and strong wheels. In the Durville process, molten aluminium alloy is poured into the mold from its inner rim side, with the disc facing downward. The alloy is then rapidly quenched and solidifies, starting at the disc side, creating a finer metallic structure significantly enhancing tensile strength, yield strength and elongation. The machine is capable of producing 19 pieces of wheel per hour. However, due to various problems which can be categorized into controllable (processes) and uncontrollable (machine breakdown) problems, the downtime is drastically increasing and production is reducing significantly. While the company's target for downtime is 2%, the current result is over 15%. Enkei (M) Sdn. Bhd. want to improve the production and reduce the downtime.

1.1.1. Project Overview

This project is, a progressive work based on the findings during the May 2016 internship program at the company.

Over the first two quarters of 2016, Enkei (M) Sdn. Bhd. had encountered challenges with its plants production. Customer orders exceeded the company delivery rate, potentially leading to unhappy customers and losses in revenue. This threatened its prided reliability in servicing its customers efficiently. It was discovered that this lapses is primarily due to the compounding effects of inefficiencies from some of its functional departments. For example, the production department produces less than its maximum or expected production capacity. The outcome of the internship findings uncovered the losses of production capacity, actual utilization capacity at one of its plant (MAC1) and suggestions for improvement were recommended.

1.1.2. Internship Findings

Table 1: Internship Findings Summary

Plant/Section	Variable		Result
MAC 1 Machining Section	Lost capacity		19.23%
	DTR		15.26%
	Downtime Causes	Machinery anomaly	59.12%
		Controlled Processes	40.88%
MAC1 Casting Section	DTR		6.09%

From May – July 2016, using the data collected over a 78 days period, as shown in Figure 1, the cumulative production of the casting section is only 87.80% of its production capacity at the current machine (Durville die casting machine) age. With the machining section, comprising three lines (Line A, Line B, and Line C) with three CNC machines, Table 1 shows a 19.23% loss of its production capacity between January and May 2016. This loss resulted in a 30.57% drop of actual production (i.e. a production efficiency of 69.43%) as shown in Figure 1. It was also conclusively noted that the bottleneck of the MAC1 production plant is the machining section, as seen in Table 13 (Appendix B), though the total production capacity of the machining section exceeds the casting section by 23.05% (Table 14).

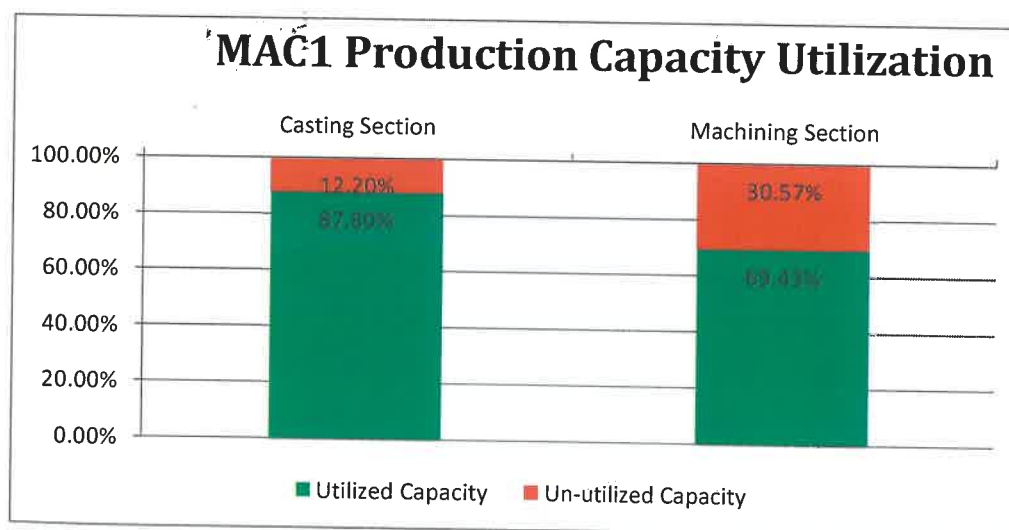


Figure 1: MAC 1 Production Capacity Utilization

Further analysis showed a down time ratio (DTR) of 6.09% for the casting section, and 15.26% for the machining section. The data analyzed was benchmarked against its production capacity in the comparison month of January to March 2016. Of the