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.

By

NELSON DAVID BASSEY
I14005232

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Negeri Sembilan, Malaysia

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APPROVAL

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by

Nelson David Bassey

A project dissertation submitted to the Faculty of Engineering and Quantity Surveying INTI INTERNATIONAL UNIVERSITY in partial fulfilment of the requirement for the Bachelor of Engineering (Hons) in Mechanical Engineering

Approved:

I. Gerald Victor P.Eng, CEng, MEng, MIChe, MIEM
Project Supervisor

INTI INTERNATIONAL UNIVERSITY
NILAI, NEGERI SEMBILAN

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.

Signature

Name NELSON DAVID BASSEY

Matrix No. 114005232

Date 28 July 2017
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 downtime. 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.
ACKNOWLEDGEMENTS

My sincerest gratitude to INTI International University for the opportunity to embark on a project which brings together the years of knowledge accumulated, and applied to achieve useful results in my chosen profession. I would also like to thank ENKEI (MALAYSIA) SDN. BHD. for providing me the privilege of access to ENKEI (M) SDN. BHD., where I fulfilled my internship requirement, and continued the work which became the subject of this project.

Immense gratitude to Datuk Dr. Siraj Khan of MASLOW CONSULTANTS & TRAINERS who opened the door to this rare privilege. Yet without the acceptance and offer of Mr Koji Inada, Managing Director of ENKEI (M) SDN. BHD., this opportunity would not have been available. Many thanks to my supervisor Ir. Gerald Victor, who had provided not only academic guidance, but professional support through the challenges encountered in the course of this project. Without him, I scarcely would have achieved the results obtained. My experience through the seven months period, would not have been enjoyable and educative without the support from Ms Shaliza Kamarudin, Assistant Engineer at Enkei Malaysia. Thank you for your warmth, grace and support.

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**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
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<tr>
<td>$P$</td>
<td>Probability of failure of equipment</td>
</tr>
<tr>
<td>$P_t$</td>
<td>Production loss in fraction</td>
</tr>
<tr>
<td>$T_m$</td>
<td>Mean time to repair</td>
</tr>
<tr>
<td>$R_s$</td>
<td>Mean cost of repairs</td>
</tr>
<tr>
<td>$h$</td>
<td>Criticality level</td>
</tr>
<tr>
<td>$&lt;$</td>
<td>Less than</td>
</tr>
<tr>
<td>$\geq$</td>
<td>Greater than or equal to</td>
</tr>
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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

<table>
<thead>
<tr>
<th>Plant/Section</th>
<th>Variable</th>
<th>Result</th>
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<tr>
<td>MAC 1 Machining Section</td>
<td>Lost capacity</td>
<td>19.23%</td>
</tr>
<tr>
<td></td>
<td>DTR</td>
<td>15.26%</td>
</tr>
<tr>
<td></td>
<td>Downtime Causes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Machinery anomaly</td>
<td>59.12%</td>
</tr>
<tr>
<td></td>
<td>Controlled Processes</td>
<td>40.88%</td>
</tr>
<tr>
<td>MAC1 Casting Section</td>
<td>DTR</td>
<td>6.09%</td>
</tr>
</tbody>
</table>

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).

![MAC1 Production Capacity Utilization](image)

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