# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

# DESIGN AND DEVELOPMENT OF AN INTEGRATED QUALITY INSPECTION GAUGE FOR WIDTH SLOT SPUR GEAR

**This report submitted in accordance with the requirement os the Universiti Teknikal Malaysia Melaka (UTem) for the Bachelor of Manufacturing Engineering Technology (Product Design) with Honours**

By

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## Faculty of Mechanical And Manufacturing Engineering Technology

**2019**

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**BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA**

TAJUK: **DESIGN AND DEVELOPMENT OF AN INTEGRATED QUALITY INSPECTION GAUGE FOR WIDTH SLOT SPUR GEAR**

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# DEDICATION

In the name of Allah, the Most Gracious, the Most Merciful and all praises to the Prophet, Muhammad S.A.W. Alhamdulillah, Praise to Allah for His Mercy. I have successfully completed this project in a timely manner.

I would like to take this opportunity to extend my utmost gratitude and sincere appreciations, to my father, Nassiruddin bin Mohammed Sapardi for his support and sacrifice to confront with all problems and difficulties along this journey, mentally and physically.Also not to forget to my mother, Ruzita Binti Ahmad Rafie for her continuous support, love and understanding.

Most thankful to manager director of Crescent Gear Solution Sdn Bhd, En Syamsyul Amry for the cooperation sharing knowledge and experiences in industry. Not to forget manager director of Impressive Transform Sdn Bhd, En Raffi Naw for kindly care of handling the project.

May Allah rewards all of you with a goodness and prosperity, here and hereafter.

# ABSTRAK

Projek ini telah dijalankan untuk merekabentuk dan membangunkan pengukur pemeriksaan mutu bersepadu untuk gear gerak slot lebar. Tujuan projek ini adalah untuk menyelesaikan isu masalah industri terpilih dari segi tolok pemeriksaan. Pernyataan masalah menentukan untuk mengukur lebar slot gear untuk mendapatkan nilai yang sama di sepanjang slot lurus. Kenyataan ini boleh diselesaikan dengan menggunakan peranti teknologi tinggi seperti Ketinggian Ketinggian untuk mendapatkan bacaan yang lebih tepat. Terdapat batasan yang dihadapi oleh industri yang merupakan peralatan penyelenggaraan dan pengangkutan untuk memindahkan gear memacu berat ke dalam makmal Pemeriksaan Kualiti. Penyelesaian cepat adalah untuk membuat tolok mudah alih di mana mampu untuk memeriksa secara langsung di tapak pembuatan. Hasil menghasilkan prototaip tolok dalam menyelesaikan pernyataan masalah yang diberikan. Terdapat langkah atau prosedur yang mesti diambil terlebih dahulu untuk mencapai hasil reka bentuk. Penggunaan fungsi kualiti dan Kaedah Pugh adalah salah satu kaedah penyelidikan yang digunakan dalam projek ini. Tiga produk, seperti tolok, jig dan kontena, direka untuk projek ini untuk menyelesaikan masalah ini. Setiap produk menggunakan kaedah pembangunan yang berbeza. Bermula dengan tolok yang memberi tumpuan kepada kaedah Penggunaan Fungsi Kualiti. QFD mengamalkan House of Quality untuk mendapatkan spesifikasi yang jelas dari suara pelanggan tepat dari industri. Melalui sekurang-kurangnya empat konsep reka bentuk yang dipilih menggunakan Matriks Penapisan dan Pemarkahan menggunakan kaedah Pugh bagi ciri kejuruteraan dan penilaian reka bentuk. Reka bentuk yang dimuktamadkan dipilih untungnya ia sama dengan tolok semasa tetapi ia digunakan untuk tujuan lain. Pepatah pergi "untuk pelbagai tujuan, menggunakan pelbagai alat". Seterusnya adalah untuk pembangunan reka bentuk Jig yang menggunakan kaedah Pembangunan Perindustrian (ID). Tahap pertama, terdapat empat tahap penyaringan seperti penyiasatan, eksploratif, penjelasan dan persuasif. Reka bentuk akhir dari reka bentuk konsep sketsa persuasif meniru kebanyakan bahan keluli tahan karat. Maklumat yang tidak menyenangkan ujian mudah dikumpulkan. Di sinilah penambahbaikan terhadap susun atur adalah penting. Pencetakan 3d lanjutan adalah salah satu pilihan yang dipilih untuk penambahbaikan fabrikasi. Selepas itu, reka bentuk akhir lebih rigid dan tipis membandingkan reka bentuk asal. Teruskan ke produk seterusnya adalah kotak alat yang digunakan untuk melindungi set gauge dan jig untuk produk akhir. Dimensi kotak adalah reka bentuk berdasarkan tata letak susunan dan susunan posisi jig. Kotak itu kemudiannya akan dihantar kepada pengrajin tempatan untuk membuat kotak itu. Mengelakkan faktor yang menggoncang di dalam kotak tolok dan jig. Untuk memegang kedudukan tolok dan jig, satu span dengan memasukkan susunan tolok dan jig bagi format masukkan dibuat. Semua fasa pembangunan yang digunakan perisian SolidWork menggambarkan reka bentuk sebelum meneruskan ke peringkat pembuatan. Kaedah ujian yang digunakan secara sistematik mengekstrak data secara praktikal dari gear slot untuk mendapatkan bacaan yang tepat untuk analisis. Produk baru ini adalah untuk membantu setiap industri gear semasa fasa pemeriksaan dengan alat rendah kos rendah dan mudah alih.

## ABSTRACT

This project have been conducted on designing and development of an integrated quality inspection gauge for width slot spur gear. The purpose of this project is to solve industry selected problem issue in term of inspection gauge. Problem statement specify on measuring the width of gear slot to get same value along the straight slot. This statement may be solved using high technology device such as Height Gauge to get more accurate reading. There are limitation the industry facing which is maintenance and transportation equipment to transfer heavy spur gear into Quality Inspection laboratory. Quick solving is to create a portable gauge where capable to inspect directly at manufacturing site. Resulting produces a prototype of gauge in solving the problem statement given. There are step or procedures that must be taken first to achieve the results of the design. Quality function deployment and Pugh Method are one of the method research that used in this project. Three product, such as gauge, jig and container, designed for this project in order to solve the issue. Each product uses a different development method. Start off with the gauge focusing on Quality Function Deployment method. QFD practicing House of Quality to get clear specification are from the voice of customer exactly from the industry. Going through at least four design concept selected using Screening and Scoring Matrix using Pugh method for engineering characteristic and design evaluation. The finalise design are selected fortunately it is similar to the current gauge but it being used for other purposes. The saying goes “for various purposes, use various tools”. Next is for Jig design development applying Industrial Development (ID) method. First stage, there are four sketching phase such as investigation, explorative, explanatory and persuasive. The final design from persuasive sketches concept designs are fabricates mainly stainless steel material. Unpleasant information simple test collected. This is where improvements to the layout are important. Advanced 3d printing is one of the option are selected for fabrication improvements. Afterword, final design are more rigid and slim compare the original design. Continue to next product is tool box used to protect the gauge set and jig for the final product. The dimension of the box are design based on the layout of gauge and jig position arrangement. The box will then be forwarded to the local craftsman to make the box. Avoiding shaking factors inside the box of gauge and jig. To hold the gauge and jig positions, a sponge with insert layout of gauge and jig for the insert format is made. All development phase used SolidWork software illustrated the design before proceed to manufacturing phase. The testing method used systematically extract data practically from slot gear to get accurate readings for analysis. This new product is to help any gear industry during inspection phase with low cost low tool and portable.

## ACKNOWLEDGEMENTS

First and foremost, I thank ALLAH (my Lord) the all great and merciful who made it possible for me to conduct this study and complete this thesis.

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## LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| 2D | - | Two Dimensional |
| AQL | - | Acceptable Quality Limit |
| CAD | - | Computer Aided Design |
| CGS | - | Crescent Gear Solution |
| CNC | - | Computer Numerical Control |
| COPQ | - | Cost of Poor Quality |
| FAA | - | Federal Aviation Administration |
| FMEA | - | Failure Mode Error Analysis |
| ISO | - | International Organization for Standardization |
| NIST | - | National Institute of Standards and Technology |
| QC | - | Quality Control |
| R&R | - | Repeatability and Reproducibility |
| RPN | - | Risk Priority Number |

# CHAPTER 1

# INTRODUCTION

## 1.1 Research Background

As markets become more diversified as quality requirements become more sophisticated, customers demand a higher level of product quality. As a competitive advantage and business strategy, quality becomes an essential element for many organizations to triumph in competition. A company with improved and well-controlled quality that takes pride in consumers can exceed its opponents.

There are several quality features to a finished product. In board terms, Quality control (QC) can be determined using inspection equipment and certain procedures to inspect and measure the product quality characteristics (Kurniati, 2015). The product can also be identified as accepted or rejected by comparing the standard if it meets or fails to meet the requirements. Inspection provides useful information that has been demonstrated on the current quality of the product. A statement made by managers dependent on this knowledge that focuses more on the effort to improve the product and process. Most inspection procedures have been constructed that are technically effective and economically efficient, particularly for acceptance inspection. Decent quality supervision shall guarantee that products meet either the manufacturer's product design department or customer needs.

Inspection and maintenance play an important role in the manufacturing system. Independently, comprehending and highlighting the opportunity, the link between quality inspection and maintenance of equipment is suggested. Observations on various publications inspire us with their relationship meaning as a way to achieve better quality assurance and performance in the production system. Therefore, the importance of quality assurance becomes ever more essential through the maintenance of equipment.

Common knowledge that gear can be seen as a product; during operation the tools reflected manufacturing inaccuracies changing the function of the movement unit. For technological reasons, the violation of gear accuracy parameters, i.e. geometric teeth deviation, is caused by reflected circumstances (Li, 2015). The principal influence of a kinematic error of the machine and tool on the cutting precision of the wheel is considered (Theissen et al, 2018), Geometric error effect is only explored on milling machines and the lathes, and these studies know well the methods of measuring geometric errors, but notwithstanding the features of gear cutting machines. The error of the gears, on the other hand, is distinguished by standard parameters. Sets standards for each degree of precision gear: tooth contact, smooth operation and kinematic accuracy. The consumer sets out his specifications as performance standards (Wąsik, 2017). The manufacturer frequently has to interact with the production errors of the technological system and it is difficult to associate these error tolerances. In particular, for gears, the problem is that a preliminary assessment of the production accuracy is complicated because of its geometry and quality.

## 1.2 Project Questions

Quality inspection is a crucial step in the process of manufacturing industrial mass production (Tseng et al, 2016). Authorization is generally used to compare the dimensional quality control model with the design model. Then in the regions of misalignment, the machined errors can be visualized. Because these two designs are positions in various coordinate systems, an optimal visual transformation matrix is required. To meet customer requirements, it is necessary to maintain the quality of each batch.

In most undesirable circumstances faced by the company, customer complaints about the quality of the product were received and their expectations were not met. The part of the product was either too small or too large to receive the customers. The Crescent Gear Solution Company normally inspected before shipping all dimensions of their products. To solve this problem, the quality management team called on all related people. In the future, a measuring device, a digital measuring table, was added to the production line by the quality management team. With high precision and accuracy, this measurement table measured the width dimension. It also simultaneously recorded measurement data electronically. When an operator measured a part of the product, a computer collected the measurement data into a sheet file for data collection.

The cost is often highly expensive for the digital measurement table. Unfortunately, this problem could not be solved by the measuring table. There were still complaints from a new customer about the shipping of the wrong size after adding the table. The new customer complained they received a product that was too small as well as too large. The quality manager's initial analysis stated that the new customer did not have the same method of measurement as the other customers because the other customers no longer complained about the issue. The aim of this project was to establish if the new quality measurement could produce accurate and accurate data and whether the accuracy and accuracy could solve CGS Company's complaint problems and increase the product quality percentages.

The research questions will be considered in this study:

i. What is the current practice in the manufacturing industry of measuring quality inspection techniques and how to improve by creating new quality inspection gauge?
ii. How to improve current gauge by modifying several quality inspection gauge for gear inspection?
iii. How can a new quality gage design assist the quality inspection process and simultaneously increase the production lane system?

## 1.3 Project Objectives

This project is to develop new quality inspection gauge for manufacturing industry in Malaysia existing company. Responding to the problem statement, the objectives of the present project have been developed as follows:

I. To identify the current practice of quality inspection gauge for width slot spur gear
II. To design an integrated quality inspection for width slot spur gear
III. To fabricate an integrated quality inspection for width slot spur gear

## 1.4 Project Scope

While there are areas in the manufacturing company those focuses on inspection sustainability issues, the interest are after operational level required checking quality in manufacturing final product. The study focused on the manufacturing company's priority and performance of maintaining the quality spec and inspection efficiency practices. Consideration was given to the three pillars of sustainability; ergonomics, efficiency and accuracy.

Realizing the significant contribution of the manufacturing industry in Malaysia, this study covered the performance of sustainability elements of manufacturing and quality inspection in Malaysia's manufacturing industry. The requirement was to visit site of selected company and focus on manufacturing industry achieved. In model development and validation stages, field visit to the Crescent Gear Solution (CGS) Sdn Bhd in Aman Perdana, Selangor were chosen for data collection.