CAD AND DOCUMENTATION OF INSPECTION JIG FOR AN AUTOMOTIVE PART

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To my beloved parents, husband, sisters, brothers and friends..

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ABSTRACT

Jig has widely used in various applications such as in inspection, machining, assembly and fabrication works. Some cases jig developmental works take more than a year to complete especially in automotive and aerospace industries where precision and safety are prime important. In most applications in small and medium scale industries, the jig design works are done manually and based on trial and error basis. This results in losses in production time and cost. With the development of computer and information technology, the design work can be simplified and the whole fabrication process can be shortened. In this project, Unigraphic software was utilized to document the design procedure and facilitate the whole jig design and assembly process via parametric part library concept. The spreadsheet function within Unigraphic software was used to parameterize all the common parts in jig application. Three case studies were used in developing the design procedure which includes two inspection and one machining jigs. The proposed procedure was written in the sequential order according to the norm of jig design procedure being practiced in small and medium scale industries. In order to design a jig, the designer has to follow the steps in the proposed procedure and match with the parametric part library database which has been developed using Unigraphic software environment. The effectiveness of the proposed procedure and parametric parts library created in the Unigraphic software were evaluated using two different jigs for machining and inspecting a motorcycle oil pump body. It is found that the proposed procedure and parametric part library concept works well for designing and assembling these two jigs.

ABSTRAK

Jig telah digunakan secara meluas dalam pelbagai aplikasi contohnya dalam pengukuran, pemesinan, pemasangan dan kerja pembuatan. Pembangunan jig terutamanya dalam industri automotif dan penerbangan kebanyakannya mengambil masa lebih dari setahun untuk disiapkan di mana ketepatan dan keselamatan adalah diutamakan. Dalam industri kecil dan sederhana kebanyakan aplikasi pembangunan jig dijalankan secara manual dan berdasarkan hasil keputusan ujian dan percubaan. Ini menyebabkan kerugian dalam proses pembuatan dari segi kos dan masa. Dengan perkembangan komputer dan teknologi informasi memudahkan kerja pembangunan dan keseluruhan process pembuatan dapat dipendekkan. Dalam projek ini, perisian "Unigraphic" telah digunakan untuk mendokumenkan prosedur merekabentuk jig dan seterusnya menggunakan konsep "Parametric Part Library" dalam process penyambungan komponen dalam rekaan jig. Fungsi "Spreadsheet" dalam perisian "Unigraphic" telah digunakan untuk menyediakan komponen asas yang mempunyai kebolehan dalam mengubah ukuran pemanjangan dalam jig aplikasi. Tiga kajian kes yang terdiri daripada dua jig pengukur dan mesin jig telah digunakan dalam rekabentuk pembangunan jig. Dalam menghasilkan rekaan jig, pereka seharusnya mengikut prosedur yang dicadangkan dan seterusnya melengkapkan rekaan menggunakan pangkalan data "Parametric Part Library" yang dihasilkan menggunakan aplikasi perisian "Unigraphic". Keberkesanan prosedur yang dicadangkan dan "Parametric Part Library" yang dibuat dalam perisian "Unigraphic" dinilai dengan menggunakan dua jig yang berbeza iaitu pemesinan dan pengukur "Oil Pump Body" untuk motosikal komponen. Pemerhatian menunjukkan cadangan prosedur yang dihasilkan dan "Parametric Part Library" dapat membentuk dan menggabungkan komponen bagi kedua-dua jenis jig.

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LIST OF SYMBOLS AND ABBREVIATIONS

SYMBOLS

CAD	Computer Aided Design
CAM	Computer Aided Manufacturing
3D	Three Dimensional
2D	Two Dimensional
D.O.F	Degree Of Freedom
MMC	Maximum Material Condition
LMC	Least Material Condition
GD&T	Geometrical Dimensional and Tolerance
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
RFS	Regardless of Feature Size
IGES	Graphics Exchange Specifications
R	Radius
CMM	Coordinate Measuring Machine
JIS	Japanese International Standard
mm	Millimeter
µm	Micrometer
CAFD	Computer Aided Fixture Design
CAFS	Computer Aided Fixturing System
GT	Group Technology
.prt	part

∠	Angularity
⌖	Position
//	Parallelism
⏥	Flatness
⊥	Perpendicularity
⌒	Profile of line
⌓	Profile of surface

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CHAPTER 1

INTRODUCTION

1.0 Background of Project

Early manufactured products were made one at a time. The craftsman started with little more than raw materials and rough idea of the finished product. They produced each product piece by piece, making part individually and fitting the parts to produce product. After several years, the quality and consistency of product varied from one craftsman to the next. From the manufacturing they realized the need for better methods and developed new ideas. The secret mass production where the standard parts with interchangeability requirement can only speed up production. These standard parts were the key to enable less-skill workers to replicate the skill of the craftsman on a repetitive work. The original method of achieving consistent part configuration is template. Template for layout, fitting permitted each worker to make part a standard design. However, this template just gave skilled worker a standard form to follow for the part. Therefore, by building on the template idea the worker constructed other guides and workholder to make their job become easier and the result more expected. These guides and workholders were the relations of today's jigs and fixture.

In automotive manufacturing industry, volume and precision of component are important aspects. Whereas, component needs to be produced should fulfill the requirement from customer and maintain it quality as per drawing. Therefore, in mass production there are special tool called inspection jigs and gauges that are ready to hold and guide the finished component during inspection process. In addition, the inspection on dimension accuracy is important to determine every product produced is within standard tolerance as required in part drawing. With uniformly, consistently and interchangeability constructed of inspection jig is thus trademark of mass produced goods. This is the specialized capital required for mass production where each workbench is different and each set of tools in workbench limited to those part operation.

The computerized system such as CAD/CAM software has assisted the development of jigs or fixtures design. A library system provided in CAD system often used to add the jig or fixture elements to the tool drawing. Using a library system in designing jig can reduces drawing time. All components are drawn to full scale in a variety of views. Each component can be called up from the library and placed on the drawing where it is required. This is how the CAD/CAM software becoming standard system in many design department for automotive industries, electronics industries and others. CAD/CAM system allows the designer build up model of jig or fixture elements with comprehensive 3D design capability, simulation, visualization tool, machining application and others. Simulation of machining in visualization helps the designer to evaluate the machining process done in good condition. Preparation on drawing documentation with updating feature tool will enhanced any improvement on part drawing in shorter time.

Therefore, for this project based on basic knowledge of jig design gathered and the understanding of commercial CAD/CAM software the inspection jig design is developed. A CAD software tool is used to help the designer in order to create the jigs elements. By parameterized jig elements can assist the designer to change the dimension of elements from part library system in order to adapt with new coming part.

1.1 Problems Statements

Literature surveys show that there has been a little work reported on measurement jig design activities. Most studies on the inspection jig design were focused on prismatic part. Whereas, in industrial environment most parts produced are non prismatic. In addition, most previous programming of jig or fixture design provided for prismatic part and machining application. The program code is not user friendly to allow any user to change the programmed. In this case, only the programmer can changed program code. Due to this problem, the system such as automated or semi-automated computer aided modular fixture still are not well accepted by the manufacturing industry due to lack intuitive interaction and intermediate feedback compared to the traditional methods such as paper and physical models.

1.2 Objectives of Project:

The objectives of this study were:

i. To propose a documentation procedure for designing inspection jig.
ii. To develop CAD parts library for common jig components
iii. To generate a parametric based of jig components using CAD software.

1.3 Scopes of Project

This project was conducted within the following scopes:

i. A stamping part was chosen as a case study.
ii. The proposed design of inspection jig had at least to consider two types of geometrical and dimensional tolerance.
iii. Unigraphic software was used to develop a data based parametric part library of the inspection jig.

1.4 Significance of Project

The use of workholding is important in both traditional and modern manufacturing systems, which directly affect the machining quality, productivity, part accuracy and cost of product. The work presented in this project was expected to provide the following benefits:

a. Inspection Jig documentation serves as an useful guideline to the workholding designer in small and medium scale industries.
b. The proposed part library database has a great potential to reduce designing and manufacturing lead time of the inspection jig.
c. The use of commercial CAD software with added functions to the workholding development process promotes more creativity to the tool designer in exploring new ideas in workholding design especially for a new product.

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