DESIGN OF JIG AND FIXTURE FOR MILLING MACHINE,
CASE STUDY: CYLINDRICAL PARTS

Thesis submitted in accordance with the requirements of the Malacca Technical University of Malaysia for the Degree of Bachelor of Engineering (Honours) Manufacturing (Process)

By

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JUDUL: DESIGN OF JIG AND FIXTURE FOR MILLING MACHINE, CASE STUDY: CYLINDRICAL PARTS

SESi PENGAJIAN: 2006-2007

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ABSTRACT

The final year project is start by the overview of jig and fixture. It is the briefly explanation about the perspective of project namely the jig and fixture. List the problem statement that can help to create an idea in order to prepare the solution of all the problems for cylindrical parts in milling machine. In order to determine the problem statement, the comparison between the milling machine and the lathe machine is needed. This is because both of these machines have significant difference in types of work piece, cutting tool and machining processes. Need to understand the objectives of this project and make sure the target is achieved. The scope of the project is totally for milling machine so need to give high focus in order to do the jig and fixture design. Besides, need to organize the works into several parts to make sure the works become more systematically. Divided the works into three main parts namely research, design and analysis. The purpose of this project is to do the case study about jig and fixture for milling machine in perspective of cylindrical work piece, a new design of jig and fixture and comes out with the jig and fixture product. Actually, there are many jigs and fixtures available in the manufacturing field so the development a new product of jig and fixture is needed. On the other hands, this design can improve the ability and characteristic of the milling machine. There are four designs of the jig and fixture for this project and all design are creating by Autodesk Inventor 9 software. By the four of the design, the analysis about the specification, safety factor, characteristic and other factor is needed then select one for the best design. The determination about the suitable material is in order to produce this jig and fixture also important. The result for this project can totally solve the problem for milling machine in perspective of cylindrical parts.
DEDICATION

For

My Family

And

Friends
ACKNOWLEDGEMENTS

Valuable suggestions, criticisms and comments have been made by numerous individuals. Greatly appreciate the time and effort the following person gave in order to complete the final year project and thanks them for their help in improving the quality of this final year project:

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<td>CAD</td>
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<td>OHNS</td>
<td>Oil Hardening Non-Shrinking Tool Steel</td>
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<tr>
<td>Mpa</td>
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CHAPTER 1
INTRODUCTION

1.1 Overview / Background

One of the most time-consuming and labor extensive processes in the manufacturing of a mechanical part is the process of work holding or fixturing. It is often remarked that only approximately 10-15% of the overall time required to produce a part is spent actually on cutting or drilling a work piece; the other time is spent primarily planning for executing part setup or work holding which is still performed by highly skilled machinists based on their experience. Recently, industries have begun to experience difficulty finding highly skilled machinists because the number of apprentices is decreasing and it is likely that the situation will worsen in the future. As a result of this trend together with the increasing power of computation speed, there has been a vast activity devoted to analyze the stability of fixturing and to automate fixture designs via CAD techniques. A fixture may constrain the motion of work pieces in two different ways. One, form closure, is purely kinematics, in which the geometry of the contacting rigid parts prevents motion regardless of the magnitude of the applied force. The other, force closure, involves the use of friction to assist in the freedom of motion of a kinematically under constrained object. Most analyses focused on the stability of the final fixture configurations and were less concerned on the sequence of placing the fixels. Based on the theories of grasping planar objects demonstrated that improper sequence of placing the fixels will result in the rotation of the planar work pieces. Instead of focusing on the fixturing of planar work pieces which ignores the sequence of placing the overhead clamp that is consider the fixturing of prismatic work pieces which
are polyhedral objects with all outer boundary faces either parallel or perpendicular to the fixture base plate. It is shown that proper sequences of placing clamps can actually relax the stringent requirement in the positioning accuracy of the fixels. So, in order to design a complete set or perfect jigs and fixtures, the determination about all the factors which are influence the jigs and fixtures during machining process is important. The factors are force, pressure, weight, cutting speed and others.

1.2 Problem Statements

Manufacturing in its broadest sense is the process of converting raw material into products. It encompasses the design of the product, the selection of raw materials and the sequence of processes through which the product will be manufactured. Manufacturing is the backbone of any industrialized nation. Its importance is emphasized by the fact that, as an economic activity, it comprises approximately 20% to 30% of the value of all goods and services produced. Manufacturing also involves activities in which the manufactured product is itself used to make other products. Examples of these products are large presses to shape sheet metal for car bodies, machinery to make bolts and nuts and sewing machines for making clothing. An equally important aspect of manufacturing activities is the servicing and maintenance of this machinery during its useful life. For this project, it is focus on the perspective of two machines which is usually used in industrial field namely lathe machine and milling machine. The lathe machine is used for cylindrical work piece and milling machine is used for square work piece. The problem here is; can the milling machine use the cylindrical work piece for machining operation and produce a new machining process that the lathe machine cannot do? That is totally can with using the jig and fixture in order to hold the work piece. The comparison between these two machines, the creating of idea to design a new product of jig and fixture for milling machine.
1.3 Objectives

The objectives for this project are:

i. To identify the locating, supporting and clamping methods and details to suit specific jig and fixture for milling machine cylindrical parts.

ii. To calculate and analyze the clamp to hold the cylindrical work piece for this jig and fixture.

iii. To design the template jig and fixture for milling machine cylindrical parts.

iv. To generate a new cylindrical work piece result by using the machining processes in milling machine.

v. To change the type of work piece used for milling machine.

vi. To construct a new jig and fixture product for milling machine.

1.4 Scope of Project

Jigs and fixtures are production-work holding devices used to manufacture duplicate parts accurately. A jig is a special device which holds, supports, or is placed on a part to be machined. It is a production tool made so that it not only locates and holds the work piece, but also guides the cutting tool as the operation is performed. A fixture is a production tool that locates, holds and supports the work securely so the required machining operations can be performed. A fixture should be securely fastened to the table of the machine upon which the work is done. Actually, this project is focus on the milling machine which is design a jig and fixture in order to change the type of work piece. So, if the milling machine’s work piece is change from square shape to cylindrical shape, it is also change the machining process on the work piece too. Although there are many types of jig and fixture, the new jig and fixture should be design so that it is suitable with the effectiveness of milling machine. Furthermore, the right dimension for the jig and fixture must be determined. This procedure to make sure the jig and fixture
can place properly on the milling machine work table. It is not important neither the
design of jig and fixture is simple nor complex but the most important thing is the design
follow the specification which is the milling machine needed. Besides, this project shall
concern with the basic rules for locating, such as positioning the locators, part tolerance,
fool proofing and duplicate location. Also the basic rules of clamping, including
positioning the clamps, tool forces, clamping forces and type of clamps selected. The
other method is the basic construction principles, such as tool bodies, preformed
material and fastening devices. In order to complete this project, the initial design of jig
and fixture for milling machine cylindrical parts need to explore and analyzed, generate
a detailed drawing with assembly of jig and fixture proposed and provides alternatives
material recommended. The discussion in this project is restricted to the milling machine
cylindrical parts. In general, my project must be presented and finally produce a new
product of jig and fixture for milling machine purpose-built.

1.5 Project Organization

For this final year project, all my works have organized in order to make sure the
progress works are always in systematically until this project done. Basically, my works
have divided into six main chapters namely introduction, literature review, methodology,
results, discussion, summary and conclusions. The introduction chapter is describing
about introducing in general for the research, investigative and project work that is
involved in the final year project namely ‘Design of Jig and Fixture for Milling
Machine, Case Study: Cylindrical Parts’. On other hands, overall of the project is
explained in briefly through this chapter. This is including the overview, problem
statements, objectives and scope of project. The literature review chapter is about past
studies in perspective of jig and fixture. Before start to do this project, learn and know
deeply about jig and fixture is important. The basic thing need to know is the definition
of the jig and fixture (the meaning of jig and fixture). Then, the describing about the
detail function of jig and fixture which is produce before in the industry is needed. The
scope of jig and fixture is broad and not limited because it have many elements such as locators, clamps, inspection devices, limits and fits, essential features of jigs and fixtures, material used and others. So, the research process must deeply in order to know and understand the factors that influence the jig and fixture before start to do the design. In methodology chapter, it is about the outline of relevant experimental, descriptive, theoretical and analytical techniques used in the research. Furthermore, it is including the detail function and design requirement for this jig and fixture, specify of material used, all appropriate design and design analysis. Through this chapter, the decision of best design for the project after does some observation and analysis for all the design. Besides, the type of material is used in order to produce this jig and fixture should be determined after do the comparison with other materials. The suitable material which is fulfilling the specification of this jig and fixture design is selected. In results chapter, it is about the analysis and presentation of data which is appropriate with this jig and fixture project. For the discussion chapter, this provides a general discussion on the results of the study, stressing the significance and implications of the findings of the research. Finally, the summary and conclusions chapter is contain a brief summary of the entire work that means from the beginning until the project done.
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CHAPTER 2
LITERATURE REVIEW

2.1 Introduction to the Jigs and Fixtures

Mast production aims at high productivity to reduce unit cost and interchange ability to facilitate cost assembly. This necessitates production devices to increase the rate of manufacture devised, to speed up the inspection devised and to speed up the inspection procedure.

2.2 Definition of Jigs and Fixtures

Jigs:
Budget may be defined as the device which holds and positions the work piece, locates or guides the cutting tool related to the work piece and usually is not fixed on the machine table.

Fixtures:
A fixture is a work holding device which on the holds and positions the work piece, but does not itself guide locates or positions the cutting tool.
2.3 Production Devices

Jigs provided with tool guiding elements such as drill bushes. These direct the tool to the correct position on the work piece. Jigs are rarely clamped on the machine table because it is necessary to move that jig on the table to align the various bushes in the jigs with the machine spindle. Fixtures hold the work piece securely in the correct position great respect to machine or cutter during the operation. There is something a provision for setting that tool with respect to work piece or fixture but the tool is not guided as in jigs. Fixtures are often clamped on the machine table. The employment of jigs and fixtures is an important aspect of workshop engineering, as their application on all but the simplest type of production smaller orders and tool room work. Jigs and fixtures are applicants this used in the manufacture or assembly to facilitate the operation to which they are applied. The primary object of jigs might be to facilitate the holding and support of and awkward or frail article for some machining operations, to position on a component, to accommodate several components which could not be held conveniently without a fixture probably the use of jigs would more than one of the objects. The distinction between jigs and fixtures is not important, but it is generally recognized that while in a jig, there is some incorporation or actual guiding of the tools or cutter.

2.4 Elements in Jigs and Fixtures

i. Locating elements
   - Position work piece accurately.

ii. Clamping elements
   - Hold work piece securely.

iii. Tool guiding and setting elements
   - Aid guiding of setting of the tools in correct position with respect the work piece.