UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF MODULAR JIGS AND FIXTURE FOR CATIA

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By

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ABSTRACT

The title of this project is Development of Modular Jig and Fixture for CATIA. The purpose of carrying out this project is to investigate the development of modular jig and fixture using the CATIA software. This project will enable students to increase their knowledge on modular jig, fixture and also the CATIA software. In the initial step of the project, many researches are done to gather information. After that, the information is gathered to create the sketch drawing which is the basic before designing the jig and fixture. When the design is ready, a library is added to the CATIA software and also the assembly and testing process. If a problem occurred during the testing process, the jig and fixture design is modified and re-tested until the required result is obtained. Finally, discussion of the result obtained are stated and some recommendations to help improve further research of the project. At the end of the report, a conclusion is drawn out from the result obtained which states on how good and further improvement that can be made for this project.

ABSTRAK

Tajuk projek ini adalah Pembangunan ‘Modular Jig’ dan ‘Fixture’ dengan mengunakan sistem CATIA. Objektif utama projek ini adalah untuk menyiasat pembangunan ‘modular jig’ dan ‘fixture’ dengan menggunakan sistem CATIA. Projek ini akan membantu para pelajar menambahkan pengetahuan mereka dalam bidang ‘modular jig’, ‘fixture’ dan juga sistem CATIA. Pada peringkat awal projek ini, banyak penyelidikan dijalankan untuk mengumpul data-data yang berkenaan dengan projek ini. Selepas itu, data-data yang dikumpul itu akan digunakan dalam proses rekabentuk ‘jig’ dan ‘fixture’. Apabila proses rekabentuk siap, cirri-ciri seperti perpustakaan akan ditambah dalam sistem CATIA, penghimpunan dan juga proses menguji. Jika terdapat sebarang masalah dalam proses menguji itu, proses rekabentuk terpaksa diulang semula sehingga mendapat keputusan yang memuaskan. Akhir sekali, analisis projek ini dibuat berdasarkan keputusan yang telah dicapai dalam projek ini. Selain itu, sedikit cadangan juga dikemukakan bagi memudahkan mereka yang ingin untuk meneruskan projek ini pada tahap yang lebih tinggi. Pada akhir tesis ini, sebuah konklusi telah dibuat berdasarkan keputusan-keputusan yang telah dicapai seperti kebaikan dan juga kajian selanjutnya bagi projek ini.

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In here, I also need to Special thanks are extended to my friends, who have show their knowledge and explain to me the function jig and fixture in CNC machine and assisting me in overcoming the difficulties throughout the project.

Last but not least, I would like to express my appreciation and gratitude to my parents for their understanding and continuous care of me during the course of the project.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

In the new millennium, technology is most important in industry. Therefore it is imperative that new technologies to be deployed to leverage the current situation. Priority is given to maximization of the current non renewable technology supply to satisfy demand of economic; on the other hand exploring new possibility on vastly untapped resources especially on areas of renewable technology sources such as machining.

Recently, technology issues have brought back a classical technology to the attention of scientific and engineering community; CNC machine promises great to produce product and also can save time. Despite industry in any country also to used the CNC machine. In fact, CNC machine need the software and program to control it. So before the CNC machine to run the product the engineers need to use the software to draw the product drawing and also write the program. This is called the CAD and CAM The software likes Solid Work, CATIA, AutoCAD and so on. Jigs and fixture also important in CNC machining, it not only save the cost and time also can to get the CNC machine easily to simulate. In this project is developing the modular jigs and fixtures for CATIA. CATIA software is a excellent and widely to use. The software not only can do the CAD but also can do the CAM.

1.2 Objectives

1. To understand modular jigs and fixture application.
2. To understand design fixturing system on CNC machine.
3. To apply CAD software in designing fixturing systems.
4. To simulate and validate to ensure the accuracy of the finished model.
5. This analyses the benefit of implementation.

1.3 Scope of Study

This project will involve design and developing modular fixturing system for CNC machine using CATIA software. And also add the component of the clamping in the CATIA library. This development is to simulate easily and also solve the programming when sent to the CNC machine. In the project, firstly, study on the theoretical of the jig and fixture. After that, going to learning the cad and cam system. Form there, comparison may be made with the information to design the jig and fixture.

1.4 Problem Statement

Manufacturers are faced with an increasing demanding market. Lead times are getting shorter and customers are calling for sophisticated products. Fierce competition is marking it harder to win new customers and keep their loyalty. In addition, industry pressure continues to build, with a growing need for standards compliance, and an inescapable reliance on suppliers. To meet the challenges of today market, manufacturers and supplier must deliver high quality products in less time, while driving costs down and improving their design processes. One major opportunity to reduce time to market is by improving tooling design of critical jigs and fixtures. The traditional 3D solutions having limitation in standardization of components, preventing their reuse in future designs and increasing design time. Due

to extensive design jig and fixture which is wasting time and facing of creating mistakes. This project was proposed to give solution of these problems. Until now, many cad software not have library, if have also not many. So this project is development jig and fixture and also browses to library. This is to get easy because some standard components no need to draw also can get in library.

1.5 Thesis Outline

Thesis outline is a summary of every chapter was described to introduce about the chapter. Chapter one (1) introduced about the basic theory, problem encounter, and the content of the thesis and also the main objective of doing the thesis. Then go to the chapter two (2) where all information about jig and fixture, the CATIA software, CAD and CAM system and also CNC machine are covered. With good references, an overview comprising history, classification and applications progressively introduce the idea behind the technology. Then is chapter three (3), methodology is to inform the process flow. After that, is chapter four (4) will perform how to create the catalog. The phase of design will show in this chapter. Then go to the chapter five (5), where the results from modular jig and fixture design will performed and assembly the product with jig and fixture by using CATIA. Besides that, also show the simulation. It includes summary of research form this project. The chapter six (6) is to discuss the problem for the project and the advantages of this development and the chapter seven (7) is recommendation and conclusion will explain in the end of this chapter.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction Jig and Fixture

Today, jig and fixtures are devices used to facilitate production work, making interchangeable pieces of work possible at a saving in cost of production. Both terms are frequently used incorrectly in shops. Jig is a guiding device and a fixture is a holding device. Jig and fixtures are used to locate and hold the work that is to be machined [1]. These devices are provided with attachments for guiding, setting, and supporting the tools in such a manner that all the workpiece produced in given jig or fixture will be exactly a like in every way.

Fixtures are important in both traditional manufacturing and modern flexible manufacturing system (FMS), which directly affect manufacturing quality, productivity, and cost of product. The time spent on designing and fabricating fixtures significantly contributes to the production cycle in improving current products and developing new ones [16]. Therefore, much attention has been paid to the study of fixturing in manufacturing.

Flexible fituring becomes necessary in FMS and computer-intergrated manufacturing system (CIMS). In FMS or CIMS, machine tools (and other equipment) are flexible for fabrication, assembly, and treatment. They are controlled by computer and linked by a material handling system to move parts from one workstation to another [16].

The fixtures employed in FMS must be adaptable in order to accommodate the wide variety of parts, thus achieving true flexibility.

The employment of unskilled labor is possible when jigs and fixtures can be used in production work [1]. Also, the use of these devices can result in such a degree of accuracy that workpieces can be assembled with a minimum amount of fitting.

A jig or fixtures can be designed for a particular job. The form to be used depends on the shape and requirement of the workpiece to be machined.

2.1.1 Production Devices

Production devices are generally workholders with or without tool or guiding or setting arrangement. These are called jigs and fixtures.

Jigs are provided with tool guiding elements such as drill bushes. These direct the tool to the correct position on the workpiece [6]. Jigs are rarely clamped on the machine table because it is necessary to move the jig on the table to align the various bushes in the jigs with the machine spindle.

Fixtures hold the workpiece securely in the correct position with respect to the machine or cutter during operation [6]. These is sometimes a provision in the fixture for setting the tool with respect to the workpiece or fixture, but the tool is not guided as in a jig. Fixtures are often clamped to the machine table.

2.2 Definition Jig and Fixture

Jigs and fixtures are devices used to locate and hold the work that is to be machined. There are generally two types of jigs used: the clamp jig and the box jig. A fixture anchors the workpiece firmly in place for the machining operation, but it does not form a guide for the tool. It is sometimes difficult to differentiate between a jig and a fixture

1. Jig

Jig may be defined as the device which holds and positions the workplace, locates or guides the cutting tool related to the workplace and usually is not fixed on the machine table [7]. Basically, jig can use in any machine for example CNC machine, drilling machine, milling machine and so on.

2. Clamp Jig

This jig device it's name from the fact that it usually resembles some form of clamp. It's adapted for use on the workpieces on which that axes of all the holes that are to be drilled are parallel. Clamp jig are sometimes called open jigs. A simple example of a clamp jigs is design for drilling holes that are all the same size. For example: the study holes in cylinder head (Figure 2.1) [7]. The jig consists of a ring with four lugs for clamping and is frequently called a ring jig .it is attached to the cylinder head and held by U-bolt clamps. When used as a guide for the drill in the drilling operation, the jig makes certain that the holes are in the correct locations because the holes in the jig were located originally with precision.

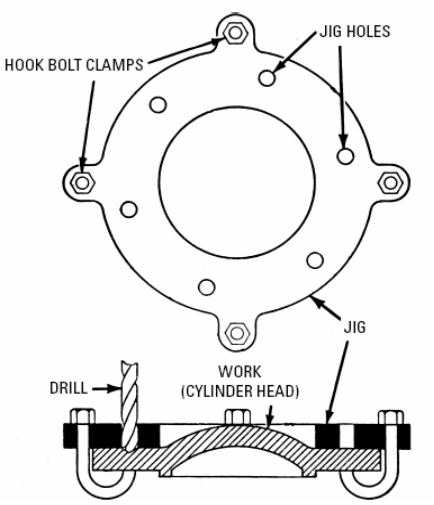

Figure 2.1 a plain ring type clamp jig [6]

3. Box Jig

Box jigs (sometimes called closed jigs) usually resemble a boxlike structure. They can be used where holes are to be drilled in the work at various angles. Figure 2.2 shows a design of box jig that is suitable for drilling the required holes in an engine link. The jig is built in the form of a partly open slot in which the link is moved up against a stop and then clamped with the clamp bolts *A*, *B*, and *C*. The bushings D and E guide the drill for drilling the eccentric rod connections, and the bushing F guides the drill for the reach rod connections [7]. The final hole, the hole for lubrication at the top of the link, is drilled by turning the jig 90°, placing the drill in the bushing G.

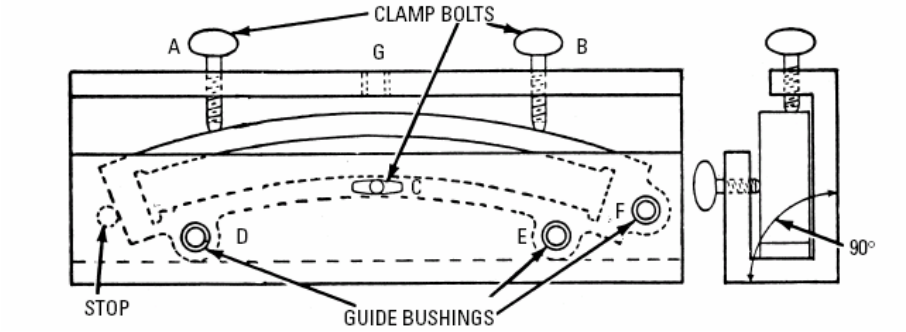

Figure 2.2: using the box jig for drilling holes in an engine link [6]

4. Fixture

A fixture is a work holding device which on the holds and positions the workplace, but does not itself guide locate or positions the cutting tool [7]. It is sometimes difficult to differentiate between a jig and a fixture, since their basic functions can overlap in the more complicated designs. The best means of differentiating between the two devices is to apply the basic definitions, as follows:

- The jig is a guiding device.
- The fixture is a holding device

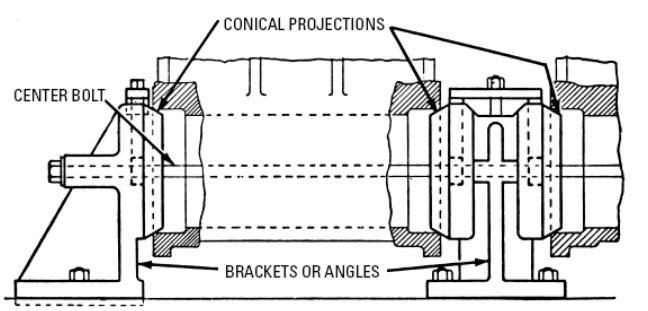

Figure 2.3: A fixture used to hold locomotive cylinders in position for planing the surfaces of the saddles.[6]

2.3 Description Of The Fixture

A fixture is a device for locating, holding and supporting a workpiece during a manufacturing operation. Fixtures are essential elements of production processes as they are required in most of the automated manufacturing, inspection, and assembly operations [2].

Fixtures must correctly locate a workpiece in a given orientation with respect to a cutting tool or measuring device, or with respect to another component, as for instance in assembly or welding. Such location must be invariant in the sense that the

devices must clamp and secure the workpiece in that location for the particular processing operation.

There are many standard work holding devices such as jaw chucks, machine vises, drill chucks, collets, etc. which are widely used in workshops and are usually kept in stock for general applications [2]. Fixtures are normally designed for a definite operation to process a specific workpiece and are designed and manufactured individually. Jigs are similar to fixtures, but they not only locate and hold the part but also guide the cutting tools in drilling and boring operations. These work holding devices are collectively known as jigs and fixtures.

2.4 Elements of Fixtures

Generally, all fixtures consist of the following elements. Actually fixtures also are to hold the workpiece when running the machining. Their have 3 examples such as locator, clamp and supports. These 3 elements will explain as below:

2.4.1 Locators

A locator is usually a fixed component of a fixture. It is used to establish and maintain the position of a part in the fixture by constraining the movement of the part. For workpieces of greater variability in shapes and surface conditions, a locator can also be adjustable [7].

Figure 2.4: Locating gages [12]

2.4.2 Clamps

A clamp is a force-actuating mechanism of a fixture. The forces exerted by the clamps hold a part securely in the fixture against all other external forces [7].

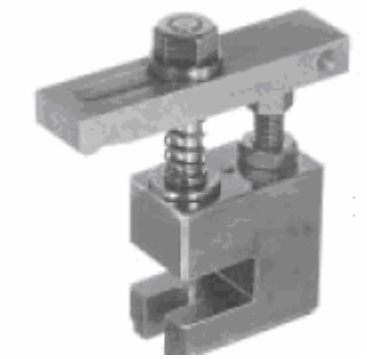

Figure 2.5: High- rise clamps [12]

2.4.3 Supports

A support is a fixed or adjustable element of a fixture. When severe part displacement/deflection is expected under the action of imposed clamping and processing forces, supports are added and placed below the workpiece so as to prevent or constrain deformation [7]. Supports in excess of what is required for the determination of the location of the part should be compatible with the locators and clamps.

Figure 2.6: Edge supports[12]

2.4.4 Fixture Body

Fixture body, or tool body, is the major structural element of a fixture. It maintains the spatial relationship between the fixturing elements mentioned above, locators, clamps, supports, and the machine tool on which the part is to be processed.

2.5 Fixture Design Fundamental

Fixture design consists of a number of distinct activities: fixture planning, fixture layout design, fixture element design, tool body design, etc. They are listed in Figure 1.4 in their natural sequence, although they may be developed in parallel and not necessarily as a series of isolated activities in actual execution [2]. Fixture design deals with the establishment of the basic fixture concepts:

- Fixture layout is an embodiment of the concepts in the form of a spatial configuration of the fixture
- Fixture element design is concerned with the concrete details of the locators, clamps and supports
- Tool body design produces a structure combining the fixture elements in the desired spatial relationship with the machine tool.

2.5.1 Fixture Design

Fixture planning is to conceptualize a basic fixture configuration through analyzing all he available information regarding the material and geometry of the workpiece, operations required, processing equipment for the operations, and the operator [2]. The following outputs included in the fixture plan:

- Fixture and complexity
- Number of per workpieces fixture