UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF WORKHOLDING DEVICE FOR LOADED PCB ROUTING PROCESS

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTEM) for the Bachelor Degree of Manufacturing Engineering (Robotics and Automation) with Honours.

By

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTEM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotics and Automation) with Honours. The member of the supervisory committee is as follow:

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Main Supervisor

(En. Ismail B Abu Shah)

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ABSTRACT

Workholding is a device that hold, grip, chuck, support and locates a workpiece to perform a manufacturing process. Suppose that for routing process of the printed circuit board (PCB), which is one of the method of the depanelization of PCB, the PCB must be hold properly so that the PCB will not slipped during the routing process which can lead to PCB damage. However, due to the condition of the PCB which is warped after the soldering process, the location of the locating support of the workholding must be determined so that it can fully support the PCB. The method used to determine the location of the locating support is known as stress deformation analysis.

ABSTRAK

Alat pengeluaran adalah sebuah alat yang memegang, mencengkam, menyokong dan menentukan kedudukan produk untuk melaksanakan satu proses pembuatan. Katakanlah untuk proses aliran papan litar (PCB), yang merupakan satu kaedah pengasingan PCB, PCB mestilah dipegang supaya PCB tidak tergelincir sepanjang proses pengaliran yang boleh menjurus kerosakan PCB. Bagaimanapun, disebabkan terdapat keadaan di mana PCB meleding selepas proses mematerі, lokasi terletaknya sokongan alat pemegang kerja mestilah ditentukan supaya ia boleh dengan sepenuhnya menyokong PCB. Kaedah yang digunakan untuk menentukan lokasi terbaik untuk meletakkan alat sokongan dikenali sebagai analisis deformasi tekanan.

DEDICATION

For everybody in my life that had supported me to finish this project especially my dearest parent, supervisor and friends.

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I would like to thank for Allah, because of His witness and abundance on me to accomplish the project within the time provided. The research has finished as planned.

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LIST OF ABBREVIATION

ESD	-	Electro-static Discharge
DOF	-	Degree of Freedom
ICT	-	In-Circuit Test
PCA	-	Printed Circuit Assembly
PCB	-	Printed Circuit Board
PCBA	-	Printed Circuit Board Assembly
PWB	-	Printed Wiring Board
SMT	-	Surface mount technology

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF PROJECT.

A printed circuit board, or PCB, is used to mechanically support and electrically connect electronic components using conductive pathways, or traces, etched from copper sheets laminated onto a non-conductive substrate. Alternative names are printed wiring board (PWB), and etched wiring board. A PCB populated with electronic components is a printed circuit assembly (PCA), also known as a printed circuit board assembly (PCBA). Depaneling is a process step in high-volume electronics assembly production. In order to increase the throughput of printed circuit board (PCB) manufacturing and surface mount (SMT) lines, PCBs are often designed so that they consist of many smaller individual PCBs that will be used in the final product. This PCB cluster is called a panel or multiblock. The large panel is broken up or "depaneled" as a certain step in the process - depending on the product, it may happen right after SMT process, after in-circuit test (ICT), after soldering of through-hole elements, or even right before the final case-up of the assembly.

Routing requires that single boards are connected using tabs in a panel. The bit mills the whole material of the tab. It produces much dust that has to be vacuumed. It is important for the vacuum system to be ESD-safe. Also the fixturing of the PCB must be tight - a usually aluminium jig or a vacuum holding system is used.

The two most important parameters of the routing process are: feed rate and rotational speed. They are chosen according to the bit type and diameter and should remain proportional (i.e. increasing feed rate should be done together with increasing the rotational speed).

Routers generate vibrations of the same frequency as their rotational speed (and higher harmonics), which might be important if there are vibration-sensitive components on the surface of the board. The strain level is lower than for other depaneling methods. Their advantage is that they are able to cut arcs and turn at sharp angles and the disadvantage is lower capacity.

Dowel-pin-based modular fixture is one of the modular fixturing available currently other than T-slot-based modular fixture. The dowel-pin-based modular fixtures have been widely applied, in which the connections of fixture components are accomplished by using a dowel pin and tapped hole. Pin holes and tapped holes are precisely machined in a rectangular (or radial) grid pattern on baseplates or other components for locating and fastening other components. The bolt-screw connection is applied to the in fixture component assemblies. As locating the elements are performed by means of dowel pins and holes, the dowel-pin modular fixture is not continuously adjustable, except using adjustable elements.

1.2 PROBLEM STATEMENT

In electronic manufacturing industry, there are two types of PCB assembly used in manufacturing which is single-loaded and double-loaded PCB. However, these PCBs must be depanelized for the next process of manufacturing to take place. Therefore, the solution is to use the manually or automatically method for the depaneling process. During this process, the PCB must be hold properly without touching the electronic components on the PCB by means of workholding jig and vacuum holding jig. The workholding is important in this process so that the PCB will be hold tightly during depaneling process by Automated Routing Machine. However, the soldering process

cause the warpage of the PCB and therefore, the PCB is not flat. This condition cause the location of the locating support of the workholding jig must be determined properly so that the locating supports of the workholding jig do not exert stress to the PCB.

1.3 OBJECTIVE.

i. To design the work holding jig.
ii. To determine the diameter of the vacuum pad needed based on the cutting forces.
iii. To analyze the design of the workholding.

1.4 SCOPE.

The purpose of this project is to develop the workholding jig to hold the PCB for the Automated Router Machine. Other than that, the cutting forces must be determined in order to identify the maximum diameter required for the vacuum pad. Besides, the design of the locating jig must satisfy the condition of easier loading and unloading.

1.5 IMPORTANCE OF STUDY.

In the electronic manufacturing industry, the application of the wokholding jig into the Automated Router Machine enables the depaneling process to be applied to any type of PCB assembly. Therefore, the application of this modular workholding jig can reduce cost by changing the orientation of the workholding jig for other type of PCB assembly instead of purchasing or build another automated router machine or specific workholding for specific PCB assembly.

CHAPTER 2

LITERATURE REVIEW

This chapter will include the definition of the development, definition of workholding device, explanation of jigs, explanation of fixtures, basic requirements of fixturing systems (ensuring positional accuracy of workpiece, ensuring operation of convenience and safety, ensuring productivity in job, batch and mass production, ensuring low production cost, and 12-point locating principle), current flexible fixturing methodologies, definition and explanation of modular fixturing (T-slot-based and dowel-pin-based), explanation about the printed-circuit board (PCB) and its characteristic, explanation about soldering process, the definition of routing, explanation about stress deformation analysis and strain gauge.

2.1 Definition of Development

Development is a broad field of endeavor dealing with the brainstorming, problem analysis, design, and creation, of new products. Sometimes referred to as new product development (NPD), the discipline is focused on developing systematic methods for guiding all the processes involved in getting a new product to market (Kumar and Phrommathed, 2005).

2.2 Workholding Device

Workholding device is all devices that hold, grip, chuck, support and locates a workpiece to perform a manufacturing process. Workholding is also known as jigs and fixtures. In addition to jigs and fixtures, vises, collets, clamps, and other similar devices are also workholders (Leondes, 2000).

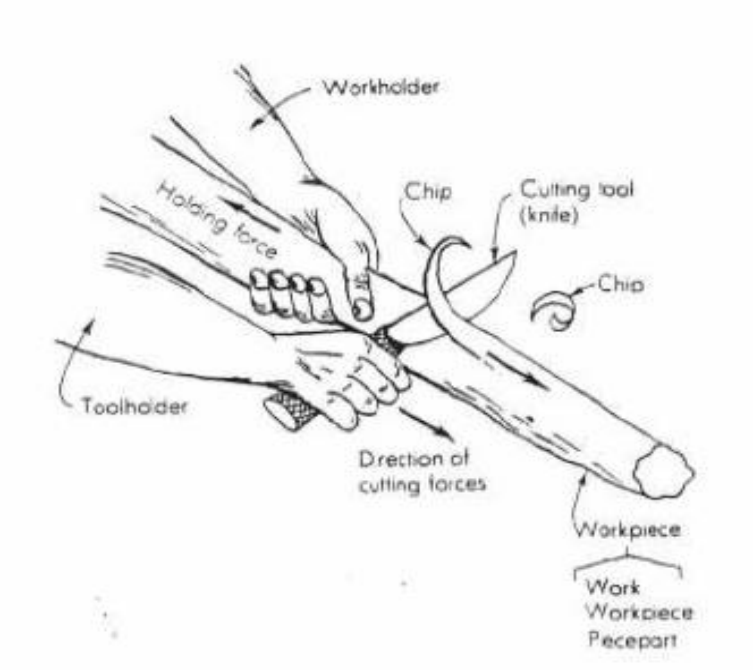

Figure 2.1: The principles of workholding

Source: www.mkn.itu.edu.tr

2.2.1 Definitions of Jigs and Fixtures

Jigs and fixtures are production-workholding device used to manufacture duplicate parts accurately. The correct relationship and alignment between the cutter, or other tool, and

the workpiece must be maintained. To do this, a jig or fixture is designed and built to hold, support and locate every part to ensure that each is drilled or machined within the specific limits (Hoffman, 2003).

The difference between jigs and fixtures can be shown in the Table 2.1 (Adithan and Gupta, 2005).

Table 2.1: Differences between jig and fixtures (Adithan and Gupta, 2005)

Jig	Fixture
Jig holds and position the work and locates or guides the cutting tool with respect to the workpiece	Holds and positions the work but does not guide or locate the cutting tool
Jig is not fixed to the machine table	Bolted or clamped to the machine table
Lighter in construction	Heavy in construction
Used on drilling, reaming, tapping and couterboring operations	Used for milling, grinding, shaping, planning, boring and welding operations

As shown in Figure 2.2, jigs use drill bushings to support and guide the tool. Fixtures, as shown in Figure 2.3, use set blocks and thickness, or feeler, gages to locate the tool relative to the workpiece (Hoffman, 2003).

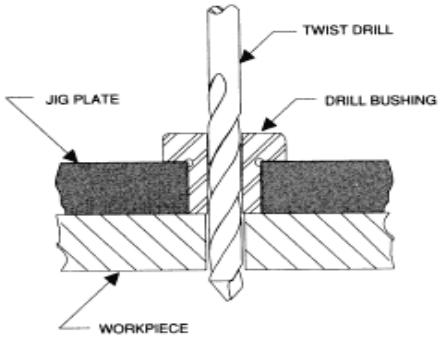

Figure 2.2: A jigs guiding the tool, in this case the drill bushing

Source: www.carrlane.com