UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Development of Linear Positioning Table for Drilling Machine

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology (Bachelors of Engineering Technology Process) (Hons.)

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering Technology (Process And Technology) with Honours. The member of the supervisory is as follow:

……

(Dr. Norfariza Binti Ab Wahab)

ABSTRAK

Operasi penggerudian adalah satu operasi yang menghasilkan lubang dengan membawa pemotong berputar menyentuh dengan bahan kerja. Operasi penggerudian biasa dilakukan dalam mesin gerudi tekan namun beberapa masa di kilang atau mesin bubut. Mesin gerudi datang di dalam pelbagai bentuk dengan yang paling biasa digunakan sebagai model bangku-atas, model lantai berdiri, model magnet dan model jejarian. Setiap model mempunyai perbezaan dari yang lain, kebanyakannya dari segi keperluan kuasa, keupayaan, kemampuan dan mudah alih. Memegang bahagian-bahagian yang hendak digerudi adalah salah satu masalah utama yang dihadapi oleh pelajar. Jika bahan yang mempunyai banyak lubang yang hendak digerudi, maka prosedur yang diterima pakai adalah menandakan dengan menumbuk pusat, menetapkan pada mesin (Drill Press Machine), dan tahan bahan kerja. Ini akan memakan masa dan mungkin berbahaya kerana pelajar perlu memegang bahan itu sendiri sepanjang proses penggerudian. Projek ini membentangkan inovatif meja kedudukan linear untuk memudahkan operator semasa proses penggerudian. Selain itu, sistem pengapitan juga akan disediakan yang menyediakan ketegaran yang lebih baik dan kurang pergerakan bahan kerja semasa proses penggerudian. Sesetengah pengapit togol adalah tetap di atas meja untuk selamat memegang jawatan sebagai sebahagian daripada bergerak sepanjang kitaran pemesinan. Tambahan pula, projek ini juga akan memberi tumpuan kepada bagaimana untuk membuat proses penggerudian boleh dilakukan dalam satu pengapitan tunggal. Reka bentuk mudah dan ekonomi adalah dicadangkan untuk membangunkan projek ini yang dijangka akan menunjukkan masa yang hebat penjimatan dalam pengeluaran. Terdapat linear lain yang serupa jadual digunakan gelongsor, tetapi perbezaan utama ialah dalam tujuan yang dimaksudkan. Tiada jadual linear yang sedia ada telah direka untuk digunakan pada mesin gerudi akhbar. Linear meja X-Y dibentangkan di dalam tesis ini mempunyai ruang kerja yang jauh lebih besar.

ABSTRACT

Drilling operation is an operation which producing holes by bringing a rotating cutter into contact with the workpiece. Drilling operation commonly done in drill press however some of the time on mills or lathes. Drill presses come in several forms with the most commonly used ones being the bench-top model, the floor-standing model, the magnetic model and the radial model. Each model has its differences from the other, mostly in terms of power requirements, capacity, affordability and portability.
Holding parts to be drilled is one of major problems faced by the students. If the material has many holes to be drilled, then the procedures adopted is marking out with a center punch, setting on machine (Drill Press Machine), and hold the workpiece. This will be time consuming and might be dangerous as the students need to hold the material themselves throughout the drilling process. This project presents an innovative linear positioning table to ease operator during drilling process. In addition, clamping system also will be provided which provides better rigidity and less movement of the workpiece during drilling process. Some toggle clamps are fixed on the table to securely hold the position of the part from moving throughout the machining cycle. Furthermore, this project also will be focused on how to make the drilling process can be done in one single clamping. A simple and economic design is proposed to develop this project which expected will shows a great time saving in the production. There are other similar linear sliding tables in use, but the main differences being in the intended purposes. None of the existing linear tables were designed for the use at drill press machine. The linear X-Y table presented in this thesis has a considerably larger workspace.

DEDICATION

I dedicate this thesis to my great family, who never stop giving off themselves in countless ways. For their endless love, support and encouragement that keep me moving forward. I also dedicate this thesis to all my dearest relatives, lecturers, and friends as without whom none of my success would be possible.

ACKNOWLEDGEMENT

In the name of Allah, the Most Merciful, the Most Compassionate all praise be to Allah, the Lord of the worlds and praise be upon Muhammad His servant and messenger, I would like to take this time to thank my supervisor or research advisor Dr. Norfariza Binti Ab Wahab for the opportunity to undertake this research project. She has provided me with endless amounts of support and guidance throughout the entire project. I would like to also thank Mr. Azimin, technician in the machine shop. Along with the machining of all of the components for the project, Mr. Azimin has been tremendous in helping with any design or assembly issues that I came across throughout this research project. Mr. Azimin's years of experience saved me countless hours in potential design flaws and mistakes. With the guidance and help from these two individuals my research experience has been nothing short of amazing. The effort and time of Dr. Norfariza and Mr. Azimin is much appreciated and greatly valued.

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A fastening device or can be known as clamp is used to grip objects securely to limits movement through the application of inward pressure. During high speed cutting process, clamping is very essential. The workpiece that are going to be machined must be clamp securely and tightly to get high precision and accurate results. However the main purpose of clamping is to hold the position of the object against the locators firmly throughout the machining cycle. The system can be described as follows:

i. The clamp should not deformed the part or damage it.
ii. The clamp should allow rapid loading and unloading of parts and be fast-acting.
iii. The clamp must have enough strength to restrict its movement and hold the parts.

1.1.1 Positioning

The positioning of the clamp should be as follows:

i. Clamps must contact the work all the time throughout machining at its most rigid point.
ii. To prevent force of the clamping from bending the part.
iii. The part must be supported if the workpiece is clamped at a point where the force could bend the part.

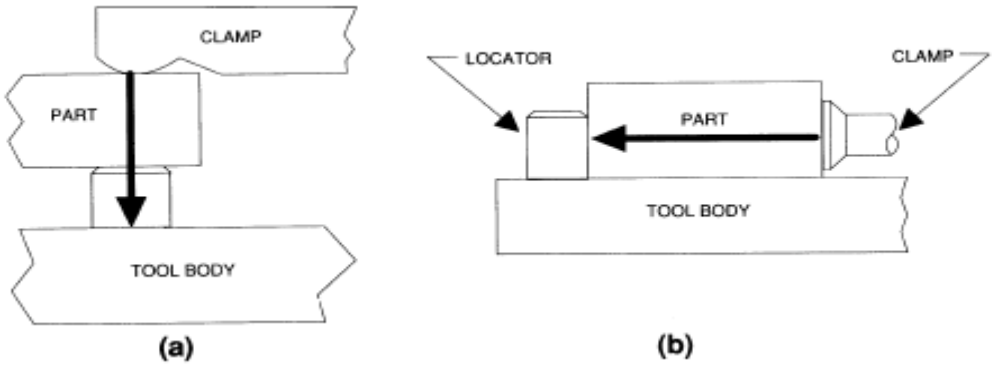

Figure 1.1 Illustration of Positioning in Clamping

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1.1.2 Tool Force

Tool force is caused by resistance of the workpiece being cut or sheared by the tool. Clamps are also positioned so they do not interfere with the operation of the tool or machine so that the operator can do the machining easily and safely. Most of the force is in a downward direction against the base of the tool and must be resisted cause the part to revolve around the drill axis.

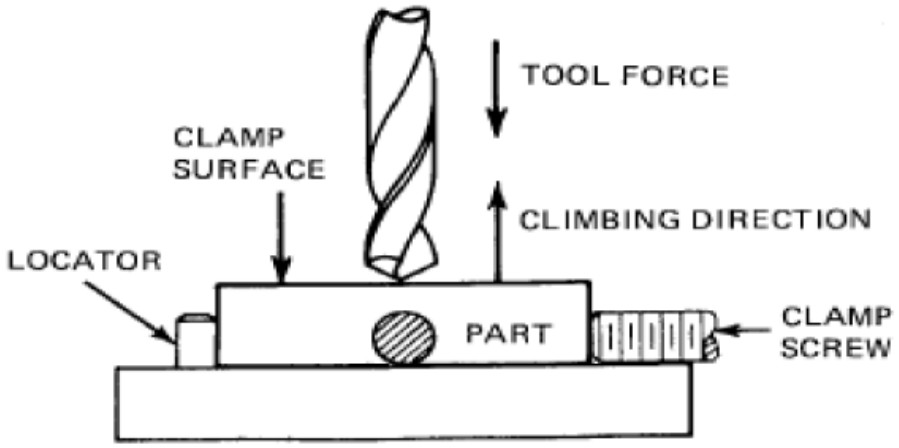

Figure 1.2 Illustration of Tool Force

1.1.3 Clamping Force

Force of clamping or can be called as clamping force is a force needed to hold a part against the locators. Thus, clamping prevents the part from shifting or being pulled from the jig or fixture during the machining operation. In addition, primary cutting forces should be directed to locators or supports rather than the clamps. The clamps should not be designed or required to resist cutting forces. Furthermore, clamping force should be sufficient to resist operation forces to keep part in position.

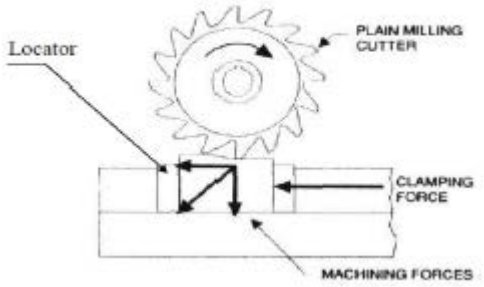

Figure 1.3 Illustration of clamping force

1.1.4 Types of Clamps

There are a few types of clamps which have their own characteristic and advantages which are:

1) Screw Clamps

It is most widely used mechanism in all kinds of fixtures.

Advantages:

i. Simple structure
ii. Large force increasing ratio
iii. Reliable self-locking property

Disadvantages

i. Slow operation speed which limits its applications in mass production and automated production.

2) Lever or Strap Clamps

i. Strap clamps are used in almost every area of jig and fixture design and construction
ii. The fulcrum is positioned so that the clamp bar is parallel to the base of the tool at all times.
iii. Because of the slight differences in part thickness, this is not always possible.
iv. To make up for these differences, spherical washers or nuts are used.

3) Power Clamping

i. Power-activated clamps are an alternative to manually operated clamping devices.
ii. Power clamping systems normally operate under hydraulic power or pneumatic power
iii. Pneumatic or hydraulic use two types of cylinders:

- Single-action cylinder
- Double-action cylinder

Advantages

i. Better control clamping pressures
ii. Less wear on moving parts of the clamp
iii. Faster operating cycles.

Disadvantages

i. Costly

ii. Easily offset by increased production speeds and higher efficiency.

4) Non-mechanical Clamping

Non-mechanical clamping is a workholding devices used to hold parts by means other than direct mechanical contact. Thus, it cannot be held with other devices due to the size, shape, or configuration of the fixtured parts. Furthermore, clamping forces must be applied evenly across the entire part to minimize any possible workpiece distortion. There are two principal forms of Non-Mechanical Clamping:

i. magnetic clamping

ii. vacuum clamping

Magnetic chucks are most often used to hold ferrous metals or workpieces made from other magnetic materials. While vacuum clamping are another style of chuck used to clamp difficult parts. While these chucks can hold almost any type of nonporous material, they are typically used for nonmagnetic materials or for parts that must be clamped uniformly. Vacuum clamping generally generated by a vacuum pump that draws out the air between the chuck face and the workpiece.

1.2 Problem Statement

i. The current drilling machine being used by the students has no clamping device yet.
ii. Less safety measure for that particular drilling machine.
iii. Work piece that have a lot of part to be drilled need to be clamped many times.

1.3 Objective

The objective of this project is to design and also develop a clamping device for drilling machine. The specific research tasks to fulfill the objectives of this thesis are summarized as follows:

i. To design a linear positioning table for drilling machines (ALZSTAR 30/S).
ii. To select the best material for the linear table.
iii. To develop a linear positioning table for drilling machine (ALZSTAR 30/S)
iv. To evaluate the complete product by using surface roughness testing.

1.4 Project Scope

This project will only cover on:

i. Design of the linear table for drilling machines is based on Drill Press Machine (ALZSTAR 30)
ii. Materials that will be selected to develop this project are mild steel and aluminum.
iii. Development of the linear positioning for drilling machine by using all machines that available at the laboratory.
iv. The result of surface roughness testing will be used to evaluate the product.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction to Machining Process

Any of methods in which undesirable material is cut to get a desired size and shape with astounding surfaces and exact measurements with adequate tolerances can be called as machining process. As of now the material removal process also can be known as subtractive manufacturing, contrasts to process of material addition, which also can be called as additive manufacturing. In metal cutting, the temperature measurement of cutting tool is being influenced by cutting factors, especially in continuous cutting operation. Since the life of the cutting tool material strongly depends upon cutting temperature, it is important to predict heat generation in tool with reliable techniques (Gosai & Bhavsar, 2016).

Machining is not only involved in manufacture of metal products, in addition, it can be utilized on other materials, for example, wood and ceramic. These days, machining is done by using computers to do all the operation and advancement mills, lathes and other cutting machine which is known as Computer Numerical Control (CNC).

Figure 2.1 Example of Computer Numerical Control (CNC) Machine

(Kalpakjian, 2005) stated that machining process, included grinding, cutting, and other non-mechanical chips-less processes, are appealing or even vital for the accompanying major cause:

i. Approximate dimensional tolerances, surface roughness or surface finish may be required than are accessible by powder metallurgy, casting, forming, and other forming processes.

ii. Materials geometries may be excessively intricate or costly to be manufactured by other processes.

2.1.1 Conventional Machining Process

In conventional machining, the capability of the cutting tool is used to pressure the material pass the yield point to begin the process of material removal. Material of the cutting tool is required to be harder than material of the workpiece. The advents of hard and strong materials for aerospace industry causing the process of material removal by conventional ways become very in addition to time consuming. This is due to material removal rate diminishes with harder workpiece.

(Kharagpur, n.d.) Stated that the major attributes of conventional machining includes of:

i. At room temperature, work-piece is softer than cutting tools moreover under certain of machining condition.
ii. Commonly, certainly seen chip formation by shear deformation.
iii. Material happens as a result of cutting forces – energy may be named mechanical.

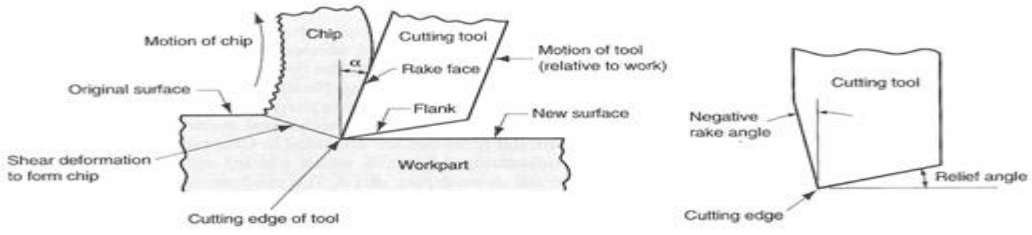

Figure 2.2 Machining Theory

Contact machining or conventional machining generally includes using an implement made of a harder material to change over the shape of a work piece. By using conventional way to machine hard and strong materials, can causes increased demand of energy and time and consequently increment in costs; and in a few cases, conventional machining won't be sensible. Conventional machining moreover costs with respect to tool wear and in loss of quality in product owing to induced residual stresses during manufacture. With consistently growing demand for manufactured goods of metals and hard alloys, for instance, titanium has slanted toward non-conventional machining strategies. Conventional machining can be described as a procedure using mechanical (motion) energy while non-conventional machining uses different types of energy. A few case of conventional machining procedure are turning, drilling, milling, grinding and slotting.

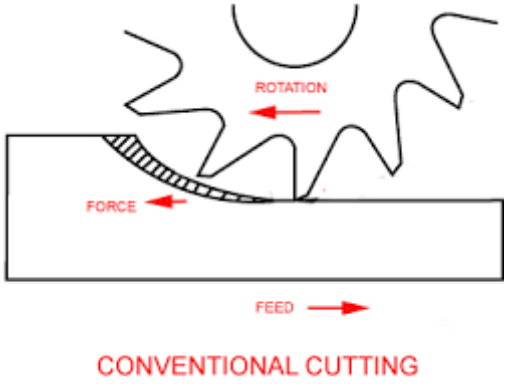

Figure 2.3 Conventional Cutting

2.1.2 Non-Conventional Machining Process

In order to realize the manufacturing/machining demands thrived by newer, hard and difficult-to-machine materials being utilized in the present day industries, an assortment of non-traditional machining processes has been developed over the past few decades. These processes are capable of generating intricate and complex shapes with high degree of accuracy, close dimensional tolerance and better surface finish (Prasad & Chakraborty, 2015).

Non-conventional machining process generally large ought to be utilized when:

1. The hardness and strength of work-piece materials are high, ordinarily > 400 HB.
2. The material is too brittle makes it impossible to be machined without harm to the part, typically the case of highly treated alloys, glass, ceramics and powder metallurgy parts.
3. The work-piece excessively adaptable or slender, making it impossible to withstand forces involved in machining or grinding, or the parts difficult to clamp in fixtures and work holding devices.
4. Special surface finish and dimensional tolerance necessities that cannot be acquired by other manufacturing process or are uneconomical.
5. Requirement for complex shapes, which cannot be machined by conventional processes at all or cannot easily be machined.
6. During processing, the temperature rises and residual stresses developed in the work-piece are not acceptable.

Figure 2.4 Example product of non-conventional machining

Non-conventional machining can be categorized by principle form of energy:

1. Mechanical processes – energy of mechanical in some form different from the action of a conventional cutting tool; disintegration of the work piece material is run of the mill.
2. Electrical processes - electrochemical energy to remove material.
3. Thermal energy processes – thermal power regularly completed to a little partition of the work surface, causing material removal through vaporization and/or combination; thermal energy is created by change of electrical energy.
4. Chemical machining processes - most materials are vulnerable against chemical attack by method for specific acids or different etchants; chemicals specifically remove material from portion of the work-piece, at the same different portions of the workpiece are secured.

Thus, classification of non-conventional machining processes is completed relying upon the nature of power used for material removal (Kharagpur, n.d.). The wide classification is given as follows:

1) Mechanical Processes:
    I. Abrasive Water Jet Machining (AWJM)
    II. Water jet Machining (WJM)

2) Electro-thermal Processes:
    i. Electron Beam Machining (EBM)
    ii. Electro-discharge Machining (EDM)
    iii. Laser Jet Machining (LJM)

3) Chemical Processes:
    i. Photochemical Milling (PCM)
    ii. Chemical Milling (CHM)

4) Electrochemical Processes:
    i. Electrochemical Grinding (ECG)
    ii. Electro Jet Drilling (EJD)
    iii. Electrochemical Machining (ECM)