

# Design and Fabrication of Pedal Operated PCB Cutting Machine

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**Abstract:** *This project describes the design and fabrication of a cutter using mild steel for the Printed Circuit Board. The board contains copper as a trace to connect the electricity current to electronic component like resistors and capacitors. The Printed Circuit Board was widely used in electronic and electric components. The normal way to cut the Printed Circuit Board is using hand due to its sensitivity. By developing the cutter, it is easy to cut the printed circuit board with more efficient without damaging the board. The performance of the cutter that fabricates using mild steel is only average due to its hardness. It becomes dull very fast. This project presents a simple way of human work will be reduced and accuracy will be improved of cutting the PCB. The system will reduce the chances to getting hurt by the blades using the fabrication and covering by protecting glass Cutting is the separation of a physical object, into two or more portions, through the application of an acutely directed force. Knife and saw are the commonly implemented cutting tools. However, any sufficiently sharp object is capable of cutting if it has a hardness sufficiently larger than the object being cut, and if it is applied with sufficient force.*

**Keywords:** Printed Circuit Board, Cutter, Pedal, Electric Motor

## I. INTRODUCTION

This project presents a simple way of designing and implementing an automatic PCB cutting machine. This machine takes the PCB from the one side and will cut the machine into the two separate pieces in required sizes and shape so that human work will be reduced and accuracy will be improve of cutting the PCB. Cutting is the separation of a physical object, into two or more portions, through the application of an acutely directed force. Implements commonly used for cutting are the knife and saw, or in medicine and science the scalpel and microtome. The goal of this project is to design and construct a PCB Cutting machine. The recent advancements in digital technology especially embedded systems have now enabled us to make low-cost machines for Real time applications.

Printed Circuit Boards (PCB) which are widely used in electronics, automobile, medical applications. Printed Circuit Boards (PCB) appeared for the first time in the 50's. Since then the world went through many revolutions on the manufacturing processes. Thus, semiconductor industry is one of the fastest growing industries in India. PCB is the heart of every electronic product. It is a thin board made of fibre glass, composite epoxy or other laminate material. A printed circuit board (PCB) mechanically supports and electrically connects electrical or electronic components using conductive tracks, pads and other features etched from one or more sheet layers of copper laminated into and/or between sheet layers of a non-conductive substrate. Components are generally soldered onto the PCB to both electrically connect and mechanically fasten them to it. Alternatives to PCBs include wire wrap and point-to-point construction, both once popular but now rarely used. PCBs require additional design effort to layout the circuit, but manufacturing and assembly can be automated. Electronic computer-aided design software is available to do much of the work of layout. Mass-producing circuits with PCBs is cheaper and faster than with other wiring methods, as components are mounted and wired in one operation. PCBs can be single-sided (one copper layer), double-sided (two copper layers on both sides of one substrate layer), or multi-layer (outer and inner layers of copper, alternating with layers of substrate).

Cutting is the separation of a physical object, into two or more portions, through the application of an actual directed force. Commonly used implements for cutting are knife and saw. Cutting is a compressive and shearing phenomenon, and occurs only when the total stress generated by the cutting implement exceeds the ultimate strength of the material of the



object being cut. The simplest applicable equation is stress = force/area. The stress generated by a cutting implement is directly proportional to the force with which it is applied, and inversely proportional to the area of contact. Hence, the smaller the area (i.e., the sharper the cutting implement), the less force is needed to cut something. It is generally seen that cutting edges are thinner for cutting soft materials and thicker for harder materials. Depaneling is a step easily overlooked in the printed circuit board (PCB) manufacturing process. The percentage of usable boards removed from a panel is known as production yield. Depanelization is simply removing individual PCBs from the array.

II. METHODOLOGY

The below flow chart shows the sequential operation/steps that will be performed during the project process.

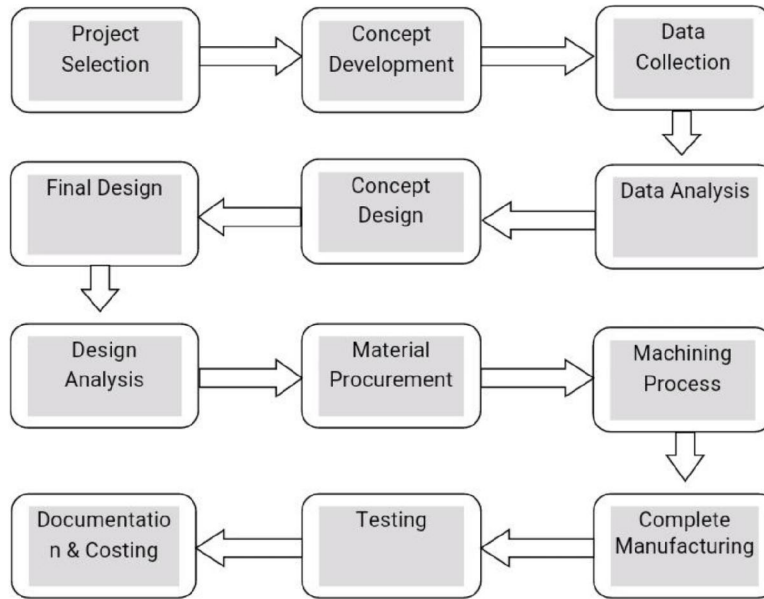


Figure 1: Flow chart of process

2.1 Construction

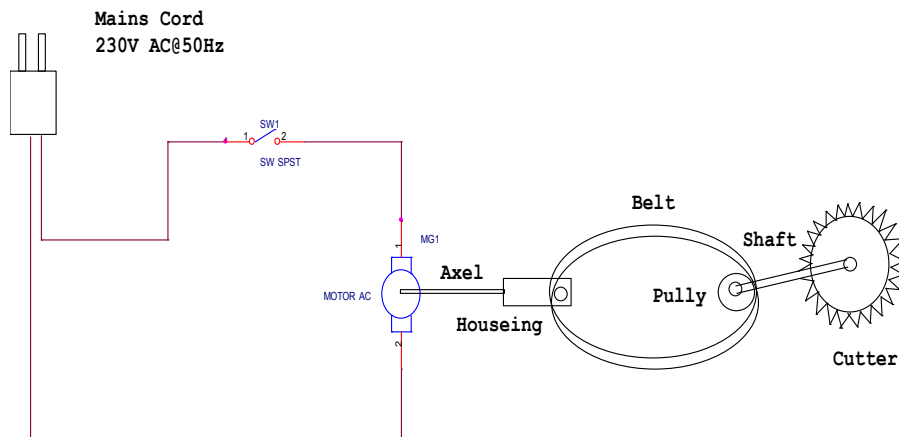
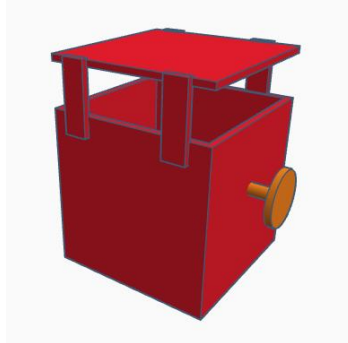


Figure 2: Block Dia. of PCB



### 2.2 Clamping Mechanism

While designing the clamping mechanisms, we had many of the options in front of us. We have two options for the cutting operation either we have to move the cutter against the stationary PCB or have to move PCB against the cutter at one position. As in first option, it is difficult to change the position of cutter which is required in case if required. So we selected second option in which PCB will move towards cutter. As the weight of PCB is very less, it is easy to move PCB and it seems very convenient.



**Figure 3:** 3D design of frame

There is a wooden board on which PCB is mounted and fixed for the operation. On these board there is a section cut so that cutter can rotate freely. In this we can also adjust position of cutter to some extent that maybe required in some case while cutting. Two flat rods are used to perfectly fix PCB so that it does not move in between cutting process. Graph paper is attached on the board for measurement of cutting of PCB. It is easy to clamp and unclamp the PCB before and after the process by using these technique. The setup also consists of two sliders to which wooden board is attached and it is used for in and out movement of PCB. These sliders are ease with handling to operator and strong enough to slide it with the better efficiency.

### 2.3 AC Motor



**Figure 4:** AC motor

An AC motor is an electric motor driven by an alternating current (AC). The AC motor commonly consists of two basic parts, an outside stationary stator having coils supplied with alternating current to produce a rotating magnetic field, and an inside rotor attached to the output shaft producing a second rotating magnetic field. The rotor magnetic field may be produced by permanent magnets, reluctance saliency, or DC or AC electrical windings



#### 2.4 Washer:



**Figure 5:** Washer

Washers are usually metal or plastic. High-quality bolted joints require hardened steel washers to prevent the loss of pre-load due to Brinelling after the torque is applied. Rubber or fiber gaskets used in taps (or faucets, or valves) to stop the flow of water are sometimes referred to colloquially as washers; but, while they may look similar, washers and gaskets are usually designed for different functions and made differently. Washers are also important for preventing galvanic corrosion, particularly by insulating steel screws from aluminum surfaces. The origin of the word is unknown; the first recorded use of the word was in 1346, however, the first time its definition was recorded was in 1611

#### 2.5 Belt

Timing belts are parts of synchronous drives which represent an important category of drives. Characteristically, these drives employ the positive engagement of two sets of meshing teeth. Hence, they do not slip and there is no relative motion between the two elements in mesh. Due to this feature, different parts of the drive will maintain a constant speed ratio or even a permanent relative position. This is extremely important in applications such as automatic machinery in which a definite motion sequence and/or indexing is involved.

#### 2.6 Bearing



**Figure 6:** Bearing

Timing belts are parts of synchronous drives which represent an important category of drives. Characteristically, these drives employ the positive engagement of two sets of meshing teeth. Hence, they do not slip and there is no relative motion between the two elements in mesh. Due to this feature, different parts of the drive will maintain a constant speed ratio or even a permanent relative position. This is extremely important in applications such as automatic machinery in which a definite motion sequence and/or indexing is involved. The positive nature of these drives makes them capable of transmitting large torques and withstanding large accelerations.

#### 2.7 Angle



**Figure 7:** Angle

Angle is used to making a frame and clamping of PCB cutting machine Angle size is 12"x 12"



### 2.8 Slider

Two sliders are used for in and out movement of PCB these sliders are ease with handling to operator and strong enough to slide it with better efficiency.



**Figure 8: Slider**

### 2.9 Cutter



**Figure 9: Cutter**

Cutter is used to cutting the printed circuit board. We have used thin kerf cutting blade because any sufficiently sharp object is capable of cutting it has hardness sufficiently larger than the object being cut.

### III. LITERATURE VIEW

It is seen that, over many years, industrial designers are working on the development of a state-of-the-art with a view to provide better clamping and handling characteristics and reliable operation. Now a days there are so many machine available in the market, which are used for processing of PCB. In these investigations various aspects of PCB cutting machine design such as, comfort, work-piece holding, safe handling, safety and reliability have been studied.

Dhirajkumar V. Patil, Nitin B. Naikwadi, Nikhil V. Patil, Nayan D. Sonawane, and Prof. Kunal U. Shinde [1] had studied about design and fabrication of portable PCB plate cutting machine. The recent advancements in digital technology especially embedded systems have now enabled us to make low cost machines for Real time applications. This project presents a simple way of designing and implementing an automatic PCB cutting machine. This machine works automatically and takes the PCB from the one side and will cut the PCB into the two separate pieces in required sizes and shape so that human work will be reduced and accuracy will be improved while cutting the PCB. The system will also reduce the chances of getting hurt by the blades using the fabrication and covering.

Rohit Choudhary, Sambhav, Sunny David Titus, Akshaya P, Dr. Jose Alex Mathew, Balaji N [2] had designed CNC PCB Milling and Wood Engraving Machine incorporates the plan and usage of a CNC (Computer Numerical Control) machine to make PCB (Printed Circuit Board) and wood etching machine in a solitary set up. The creation of this machine is to



diminish the cost and multipurpose nature of machine. This venture manages the plan of programmed scaled down CNC machine for PCB drawing and processing. These advancement would be profoundly practical in contrast with that of customary manufacture hardware.

Heying Wu and Haiyan Zhu [3] had research on the common causes of defects and their prevention measures for rcf-type PCB mills production. Blade-type error, edge collapse cutaway, micro missing, four kinds of defect for RCF-type PCB mill production are deeply analyzed and their preventions measures are given detailed according to the author's many year's practice. These measures have been practiced and achieved better results. The research results can increase pass rate of such tools in the production and reduce production costs obviously, and owns with a special important using values and widely promoted significance., Rodrigo Basniak, Marcio Fontana Catapan [4] represent the design of PCB milling machine. A better process is with milling and a CNC machine. There is a lack of CNC machines for this purpose, so this paper presents the development of a CNC milling machine for printed circuit boards with low manufacturing costs for domestic use. The customer requirements are obtained through a market research and then processed with the use of a QFD matrix to acquire the product requirements. A morphological matrix is then used to obtain all possible solutions for each requirement and they are analyzed with an algorithm to find the best concept for this product. With a functional prototype finished many tests are done to assure that all customer requirements were fulfilled.

Prabhanjay Gadhe, Vikas jangir, Mayur yede, Wasim-Ulhaq [5] had designed and implementation of PCBusing CNC, where the drill holes and the layout are automatically find out from an image of the circuit in EAGLE software. These paper mainly focuses on the design and implementation of automatic PCB milling and drilling machine using ARDUINO UNO. Further the drilling machine uses path planning through co-ordinate measurement machine methodwhich is useful to make the system more stable and accurate.

Vishal G.Chhaya, Raviraj D. Gohil, Rohit R. Raval [6] had researched about design and manufacturing overviewof PCB drilling machine. Drilling was done in the field of metal cutting for mechanical parts since; in this case, high precision and quality are needed. De lamination and extensive tool wear are major problems which drilling of composite materials are currently facing. In this paper we have focused on design and manufacturing of drilling machine to drill a small size hole on composite material like PCB.

Chirag R Prajapati, Prof. Dhaval P Patel, Mr. K.S.Parmar [7] had presented the modelling and analysis of frame structure of PCB drilling machine. Other processes for producing holes are punching and various other advanced machining processes. The cost of holes making is one of the highest machining costs. There are several types of drilling which are gun drilling, twist drill, and trepanning. The most common drill out of all is the conventional twist drill. The main objective of research paper is to reduce vibration of frame structure of PCB drilling machine. By applying propose material selection for structure and optimize dimension of structure from data of present PCB drilling machine and change geometry and material of structure. M. M. Noor, M. M. Rahman, M. A. Hassan, Z. Ghazalli [8] had developed a cutting tool with mild steel Department of Mechanical Engineering, MCOERC, Nashik for printed circuit board. The caprum as a trace to connectthe electricity current to electronic component like resistors and capacitors. The normal way to cutthe printed circuit board is using hand due to the sensitive material of PCB. By developing the cutter, it is easy to cut the printed circuit board with more accuracy and in efficient way without damaging the board. The performance of cutter that fabricates using mild steel is only average due to its hardness.

Xiaohu Zheng, Dapeng Dong, Lixin Huang, Qinglong An, Xibin Wang, Ming Chen [9] researched on fixture hole drilling quality of printed circuit board. The parameters involved in drilling quality are burr size, holewall roughness et al. In this study, the drilling machinability of PCB fixture hole is studied, effects of drilling parameters on various parameters such as thrust force, quality etc. are discussed. The experimental results show that resin will be melted during the drilling process. Analysis of variance (ANOVA) is carried out for hole quality parameters. Desirability function method is useful for multiple response optimization to obtain the optimal tool geometry parameters.

Jitendra Singh, V. K. Jain, J. Ramkumar [10] had concluded the Fabrication of complex circuit on printed circuit board (PCB) using electrochemical micro-machining. Electrochemical micro-machining (ECMM) is an advanced machining process for machining of electrically conducting materials. In the present work, an experimental set-up for ECMM is used to fabricate complex circuits on a printed circuit board (PCB) by means of masking technique. After all the experiments have been completed, the circuit is compared with the main circuit which is fabricated by milling process and percentage error present in the circuit after the completion of process is evaluated.



Tsung-Ming Lo, Jieh-Shian Young [11] had studied the productivity for PCB Drilling by Laser Driller Machine. The goal is to reduce the process time required for a PCB work piece. Applicable techniques for reducing process time includes reducing the number of Galvo tiles, and path planning improvement for either tiles or holes. The noncrossing path approach proposed in this paper generates a shorter path for both platform positioning and drilled holes in tiles. Results show that the reduction method for the number of tiles and the non-crossing path algorithm for both tiles and holes can increase productivity by approximately 16~17%.

N. Sathyakumar, Kamal Prasath Balaji, Raja Ganapathi, S.R.Pandian [12] had developed three axis CNC PCB milling machine. Practical hands-on laboratory teaching and experimentation is necessary to improve learning in electronics. In this paper, a low-cost build-your-own (BYO) semi-automated three-axis PCB milling machine for double sided PCB prototyping is developed using commercial i.e. both left-justified and right-g

IV. RESULT AND DISCUSSION

Time required cutting the PCB plate. Conventional PCB is a single layer of circuitry or can go to 50 layer or more.so into conventional PCB plate cutting machine is more Designed PCB is printed circuit board your electronic circuits to life in the physical form. Using layout software the PCB design process combine components.

| Sr. No. |                                    | Conventional PCB plate cutting machine | Designed PCB plate cutting machine |
|---------|------------------------------------|--|------------------------------------|
| 1       | Time required to cut the PCB plate | More                                   | Less                               |
| 2       | Chances to break the material      | More                                   | Less                               |
| 3       | Accuracy                           | Less                                   | More                               |

Figure 9: Result

V. CONCLUSION

There are many significant benefits with hydraulic clamping systems. The major advantage of hydraulic clamping is that it significantly reduces the load and unloads times compared to conventional manual clamping. This results in higher capacity utilization on all types of machines. Hydraulic clamping also offers improved quality due to consistent and repeatable clamping forces being applied. Totally automatic operation is also possible with hydraulic clamping. By means of theoretical calculation, a new kind of feasible and effective oil cylinder is designed, because of which automatic clamping of the work piece can be guaranteed. The machine has not only obtained the national utility models patent but also has been put into production. Besides, it is applied to the seamless steel tube enterprise and has created substantial economic benefits to the producing enterprise. It reduces or sometimes eliminates the efforts of marking, measuring and setting of work piece on a machine and maintains the accuracy of performance.

ACKNOWLEDGMENT

I would like to express my special thanks of gratitude to Project guide and source of inspiration Mr. L G. Kamde or his valuable guidance to make my project towards perfection.

I am also extremely grateful to our HOD Dr. J.H. Bhangale Project Co-ordinator Mr. G. D. Katala for their various suggestions and all staff member of Mechanical department for their constant encouragement and kind help during my project for providing all facility & help for smooth progress of project work. I would also like to express sincere gratitude towards our Principal Dr. G. K. Kharate for being supportive and always encouraging.

“I always pray to god to shower his blessing on me without nothing is possible to be done.”

Last but not least , the backbone of my success & confidence lies solely on blessing of my parent and my best friends.

Thanking You.

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