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# Wood Carving Based on Computer Numerical Control (CNC)

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**Abstract:** The development of wood carving machines based on computer numerical controls (CNC) is an innovation that researchers are translating into today's technology world. This carving machine was developed because wood carpenters in the Small Medium Industries (SMEs) are still using manual carving methods with the use of hand tools. This manual carving method has raised several issues including shortage of skilled labour, low productivity, and lack of capital to own a wood carving machine. Therefore, the development of wood carving machines based on the computer's numerical controls can assist entrepreneurs in solving any problems arising in the process of manual wood carving. The researcher has used the Engineering Design Process (EDP) development model as the main reference that involves the process of analysis, design, development, implementation, testing and evaluation in developing this machine. The testing consists of a carving time test, carving accuracy test, carving depth test and electrical test on the control circuit. Thus, the objectives of the development have been achieved.

**Keywords:** Wood Carving, Computer Numerical Control (CNC)

## 1. Introduction

In Malaysia, wood carving is a type of woodwork produced by hand tools such as engraving blade, chisel and hammer. The carving of a pattern depends heavily on the skills and expertise of an individual towards Malay culture. This can be seen in wood carvings of Malays who have the characteristics of traditional and contemporary. In this regard, the Malaysian furniture industry can appear as the top 10 exporters and the most important in the World (Mohd Rafi Yaacob, 2014). However, most of the wood carving industry is still using traditional ways to produce their product and some issues arising from SME operators. Among the challenges that arise are the lack of skilled carver, low productivity levels and lack of capital to have own wood carving technology.

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The shortage of skilled carvers occurs when the wood carving industry is difficult to get the carve tools in handling hand equipment for carving woods. The handling skills of hand tools are highly needed for a woodcarver to produce high quality, efficient and beautiful carvings. In addition, a carver must have very high expertise and thoroughness in wood carving art. This is because the process of carving for a pattern or shape on wooden surfaces is very complicated. It requires very high patience in making the shot right on the wood.

The second problem that arises is low activity of production. The time taken by carvers to finish one project is highly dependent on the level of pattern required by the customer. For example, a flower sculpture can take up to one hour to be completed by carvers. In addition, the entrepreneur also had to bear the risk of wastage, often due to carvings that were not being made perfectly or precisely. This contributes to the increasing raw materials cost.

Therefore, innovation using efficient technology needs to be created. One of them is through developing a machine mechanism to perform the process of engraving in order to overcome problems and constraints that arise. The machine technology will have a system where customers can obtain carvings of wood according to their design or painting in the form of 2D. The development of this machine technology should include the necessary aspects of the SME operators of wood consisting of functionality, quality and productivity of output, safety, ergonomics, price and time. In addition, the price of this machine must be reasonable and affordable by SME operators of wood carving. Therefore an alternative effort from researchers to develop a computer-based wood carving technology aims to solve the problems found in the manual wood carving process. The development of this machine technology consists of several combinations of electronic technology and modern number numerical controls that can operate automatically without eliminating the originality of carving art.

Based on the problems stated, the objectives of this project are (i) To design wood carving machines based on computer numerical controls (ii) To determine the requirements of machine tools in terms of mechanical, electrical and software (iii) To assemble and test machine components' performance by producing or engraving types of engraving in 2D form.

The idea of designing and developing the wood carving machine was based on many previous studies. The study of Quatona, Simone, Rivera and Guida (2017) showed that to replace the existing motion controller then used the latest technology in the field of machining that is the Fieldbus drive . Research by Yu, Hu, Xun, Yan and Du (2009) used an open-source control system designed as a control system, which was modified for use in 3D printing machines. While this study focuses on the driving force of the drive system.

The studies conducted by Elias, Yusof and Minhat (2013) and Yusof, Kassim and Zamri (2010) are related to STEP-NC rather than widely used G \* M systems. The study by Yusof, Kassim and Zamri (2010) focuses only on the testing of the new STEP-NC code generator (GEN-MILL) on its functionality based on example 1 ISO 14649. Elias, Yusof and Minhat (2013) used Labview software to produce STEP-NC data model simulation of sections 10, 11 and 111. Research by Abdalla, Mohamed, and Babiker, (2016) focused on the use of CNC machines to create PCBs where the CNC machines are built on their own.

Based on the studies that have been discussed, it can be seen in the developments in the manufacturing industry involving CNC machines. Some researchers use those devices from open source to develop or modify existing CNC machines. Additionally, there were also suggested by other studies such as increasing the scale of the machine (ref), using a stronger motor and building a machine frame than aluminium (ref). However, the development of CNC machines using open-source devices for teaching aids use is not implemented. Therefore, the researcher developed a CNC machine by using a device from an open-source that is also suitable to be used as teaching aids.

## 2. Methodology

The Engineering Design Process (EDP) was used for the development of wood carving machines. There are four phases included in the process which needs analysis, design, development and implementation phase and testing and evaluation phase. Table 1 explains the process for all phases.

**Table 1: EDP process**

Phase	Description
Need Analysis	Need analysis is a method to identify the problems faced by SMEs woodcarvers in the wood carving process. A semi-structured interview with the carpenter and two woodcarvers in Kuala Terengganu has been done. The purpose of this interview is to address the problem facing woodcarvers and to get the idea of innovation that can be developed to help them solve the problems.
Design	In the design phase, the selection of electrical machines parts, product specifications and software that are suitable were chosen.
Development and Implementation	The development of the product is divided into three main parts which are (i) the development of the machine body (ii) the development of the circuit to control the machine (iii) the development of the users manual. The body of the machine will be developed according to the design specifications selected in the second phase. The control circuit will be developed according to the ladder diagram constructed. Meanwhile, manual users will be developed to guide users in installing the software on their computer and how to run the machine step by step.
Testing and evaluation	Testing phase is the process to make sure the wood carving machine works as prescribed. The testing process consists of carving time test, carving accuracy test, carving depth test and electrical test on the control circuit.

### (i) Design of wood carving CNC

Figure 1. shows a block diagram of a wood carving machine based on CNC. There are four steps and below is the discussion of every step. .

#### **Figure 1: Block Diagram of Wood Carving Machine Based on Numerical Control Computer Design**

The first step in a wood carving machine based on numerical control operating was to calibrate the machine, it was aimed at understanding if the stepper motor and any other mechanism operated according to the software that was programmed. Followed by setting the starting position of the spindle motor drill on the wood carving machine both automatically and manually by hand spinning using Universal G-code Sender software. A maximum speed of 1200 rpm (rotation per minute) can be set to spindle motor speed. After calibration of the CNC machine, the design with the \*.gcode extension format was uploaded with serial communication using Universal Gcode Sender to Arduino Uno.