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# WOODEN MASK MAKING TECHNIQUES WITH 3 AXIS CNC ROUTER MACHINE

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**Abstract:** This study aims to determine the technique of making wooden masks with a 3-axis CNC Router machine and to compare the time and quality of the results of making masks manually. This research method uses cangkring wood, mahoni wood and pule wood. The design process with the help of the CorelDraw software, Aspire vectric. Manufacturing process with the mach-3 software. The machining process of a 3 Axis CNC Router with a variety of machining roughing and finishing with a variety of tool paths, step over, step down, spindle rotation, plugrate, feederate, and machining time. The results showed making wooden masks with a CNC Router machine has a faster time, uniform shape and size than manual making. Pule wood material provides a faster yield, smoother surface, and machineable than cangkring wood and mahoni wood. The machining time of the CNC router for making one wooden mask is 2 hours-20 minutes for cangkring wood, 3 hours-06 minutes for mahogany wood, and 2 hours-07 minutes for pule wood.
**Keywords:** wooden masks; CNC machines; machining time; varied designs; productivity;

## I. INTRODUCTION

Along with the development of micro, small and medium enterprises (MSMEs), especially wood mask craftsmen in the Magelang City, their production still faces several obstacles, it takes a long time to make a wooden mask manually, while market demand is getting higher and higher. It takes one day to make a wooden mask, apart from a long time, the results of the manual crafting process cannot be uniform in size. Figure 1 shows the manual manufacture of a wooden mask According to Andi Topeng craftsman in the Trasan area Magelang City said that the price of masks offered by Mr. Andi varied greatly, depending on the type of mask and the carvings. If the carvings are good, the mask can cost up to IDR 400,000 - IDR 500,000. For the price, usually the masks of PANJI TUMENGGUNG and rum are priced around IDR 300,000 - IDR 350,000, while for the samba and KELANA masks the price is around IDR 350,000 - IDR 400. 000. Mask is the oldest expression of cultural heritage in Indonesia. Previous research has described wooden masks as a sociocultural and technological depiction of the past stored in museum. The essence of establishing museum is to understand language of the people of Oron region, especially their sociocultural and technological attainment in the time past.[1] Wood properties are fundamental for the conservation of artworks. The depth knowledge of works of historical and artistic importance allows to assess the state of conservation and to support the choice of the most appropriate methods of intervention for the maintenance.[2]

In this aspect of production, there are 3 main things that need attention, namely raw materials, production processes, finishing goods processes and technology used. The main raw materials for wooden mask crafts are cangkring wood, mahoni wood, and Pule wood. Currently there are still quite a lot of wood available in the Magelang and surrounding areas but need attention to hold rejuvenation of wood planting.

Figure 1. Making a wooden mask manually

In the research activity of policy analysis for the development of small wood mask craft industries, states that there are problems, namely the ability to create and innovate wood mask craftsmen is still low, the equipment and technology used by craftsmen is still simple. To optimize the production process, craftsmen need to be encouraged to use 3-axis CNC router machine technology [3][4]. Variations in water content in wood produce different levels of surface roughness. In Bali, labor and capital factors. In this study, it is stated that labor and capital have a significant effect simultaneously on the wooden mask industry.[5][6] The proposed research now has the novelty of applying CNC router machine technology to manufacture wooden masks to increase productivity with better results, varied designs, uniform shapes and sizes.

The current problem for Andi Topeng in Trasan, Magelang City is simple equipment that depends on the craftsmen's skills. The time it takes to manufacture old wooden masks, vary in shape and size so that it requires machine technology and understanding the importance of maintaining product quality, an effective production approach. Figure 2 shows making a wooden mask with a CNC router machine.

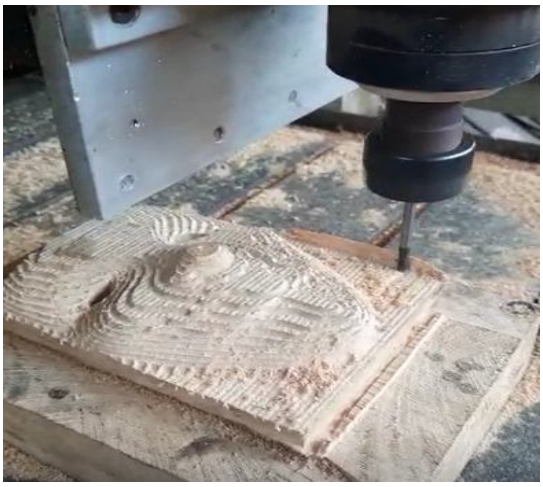

Figure 2 Making a wooden mask using a CNC Router machine

The purpose of this study found Wooden Mask Making Techniques with 3 Axis CNC Router Machine for in order to improve the quality, production capacity, expansion of marketing network, and competitiveness.

## II. METHODS

The time and location, reserach activity conducted in July-September 2020 in the Campus of the State Polytechnic of Semarang and CV Retro Kreasi Machinery (RKM) Semarang. Figure 3 shows the research flow diagram.

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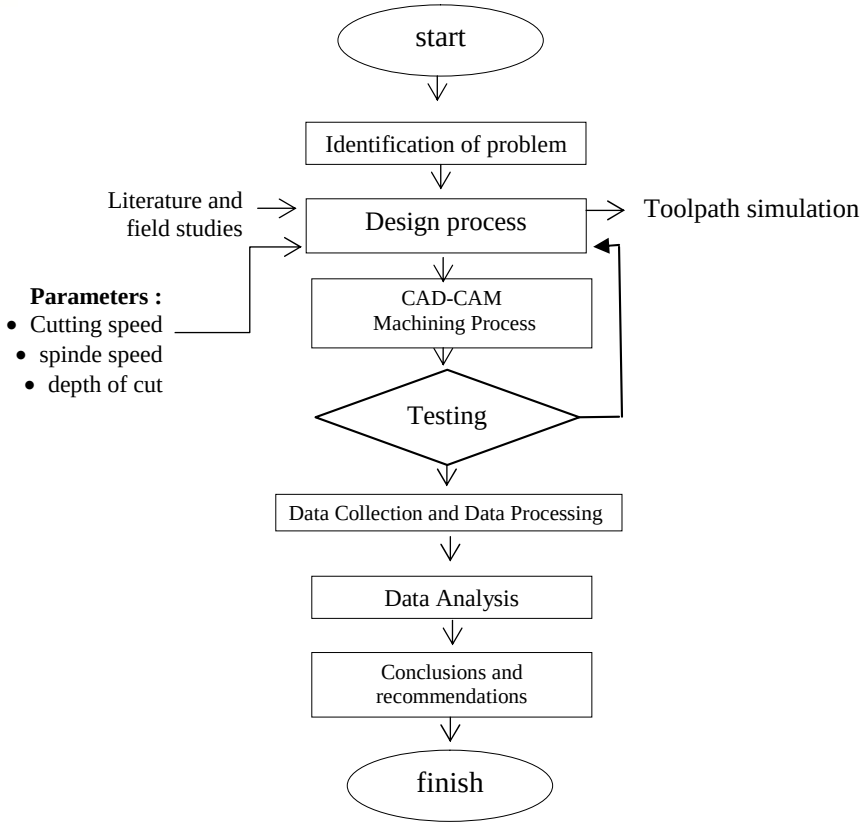


Figure 3. Research Flow Diagram

## III. RESULTS AND DISCUSSION

### A. Work Piece

- Name: Wood Mask Engraving with CNC Router Machine
- Material : Cangkring wood, Mahoni wood, Pule wood
- Size: 132mm x 194mm x 70mm

### B. Machining Parameters

- Cutting tool type : FLAT HSS / CARBON TIP
  : CARBITE BALL NOSE
- Cutting tool size : Ø 8mm Flat endmill and Ø6mm ballnose
- Feedrate : 3000 mm / min
- Spindle speed : 12000 rpm
- Number of cuts : 2
- Step Over : 1.5 mm
- Plug Rate : 1500 mm / min
- Clearance step over : 1.92 mm

### C. CAD-CAM Software [7][8]

- Aspire Vectric
- Mach3

Open the program Aspire Vectric on a computer, the images selection is suggested from the picture CAD (Computer Aided Design) which has been made in format .stl or .step earlier and put in Aspire by inserting 3D bitmap. If the settings in the CAD software and the aspire vector are the same as the actual size, the design drawing will be displayed properly, and have the same level of precision. Figure 4 shows the view of a wooden mask design in the Aspire vectric software

### D. Select 3D Roughing

Early Programming or roughing it takes to make the form step by step . Select a tool, click Select tool to select the type of tool available on the Aspire Vectric Software. Select a tool with usage specifications; here I use the flat endmill 6 mm Edit tool to change the parametric tool by clicking the edit button. Edit the tool to change the parametric tool based on the needs of the tool that will be used in program execution,

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Set it as in the existing parametric. Replacing Raster-X and Raster-Y. To change the parametric Raster-X and Raster-Y is a material is used, in other words, materials that have fibers, so it is advisable to use a raster opposite the wood contour so that no damage occurs during machining.

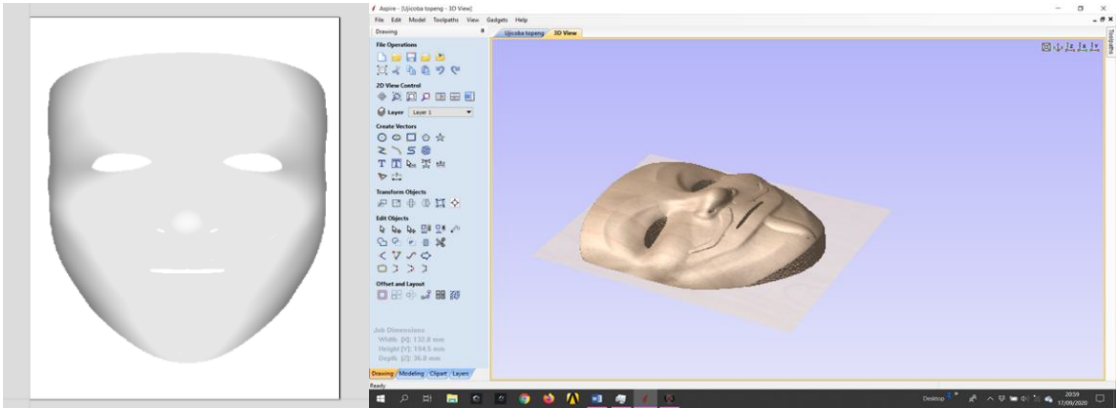

Figure 4. Aspire mask design view

Selection of Last, First and None. It is recommended to use First because the first cut must be or start from the nearest X-0 or Y-0 which is closer. This is done to see if the selected move is wrong or not. Ramp Pluge Moves to change the blue tick with or without Calculate ramp pluge moves. After editing the tool, calculate the program by pressing the calculate button at the bottom of the menu. Pre-view tool. When finished, press the pre-view tool button then see if there are any irregularities in the existing program. Like a pierced object or a line out of an existing frame. Figure 5 shown the final result of the work piece roughing toolpath simulation after pre-view with Aspire vectric software.

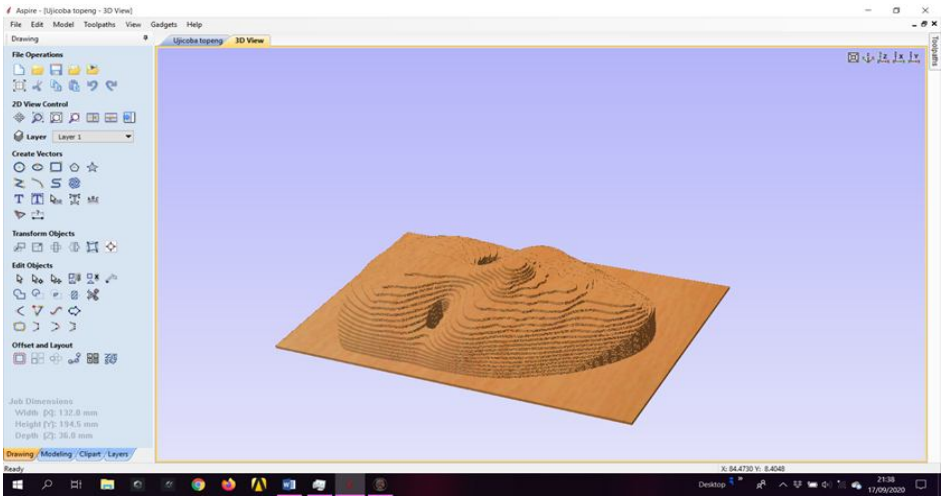

Figure 5. Roughing toolpath results with Aspire

### E. Select 3D Finishing.

If there are no problems with the roughing process, then go to the next step, namely 3D finishing, to make a wooden mask with a smooth surface. Select a tool, in selecting a tool to create a 3D finishing program, it is advisable to use a tool with a small angle or with a radius specification, this is used so that the manufacturing or execution process gets the best and smoothest results.

Toolpath menu, in selecting a tool using a tool with a specified radius, or using ballnose. Edit the tool by changing the parametric tool based on the needs of the tool that will be used in program execution, set it as in the existing parametric. Select the boundery material, in this case it is recommended to use a boundery because it is so that the tool is free from residual chipped. Select raster or offset, in this case it is advisable to use the raster toolpath profile so that the finishing results can be the same motion as 3D roughing that does not cut the wood contour. Calculate, after editing the tool, calculate the program by pressing the calculate button. Pre-view tool. When finished, press the pre-view tool button then see if there are any irregularities in the program, for example, a workpiece is penetrated or a line comes out of the existing frame. Then check the machining time and closed. Save the program, if you have finished doing it then save the program or import it into G-Code.

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Figure 6. Finishing toolpath results with Aspire

## F. Enter the program to Mach-3

a. Open the mach3 program in the window
b. Eliminate reset or emergency, to run the first machine command by removing the reset or emergency button.
c. Load the program, input the program with load G-code and input the selected program.
d. The machine is ready for the setting of 0, the engine is in travel home is done to keep the engine is not an error.

Figure 7 shows the Display Save view, Figure 8. Shown Aspire Program positions and Figure 9 shown Setting 0 at Mach-3 program.

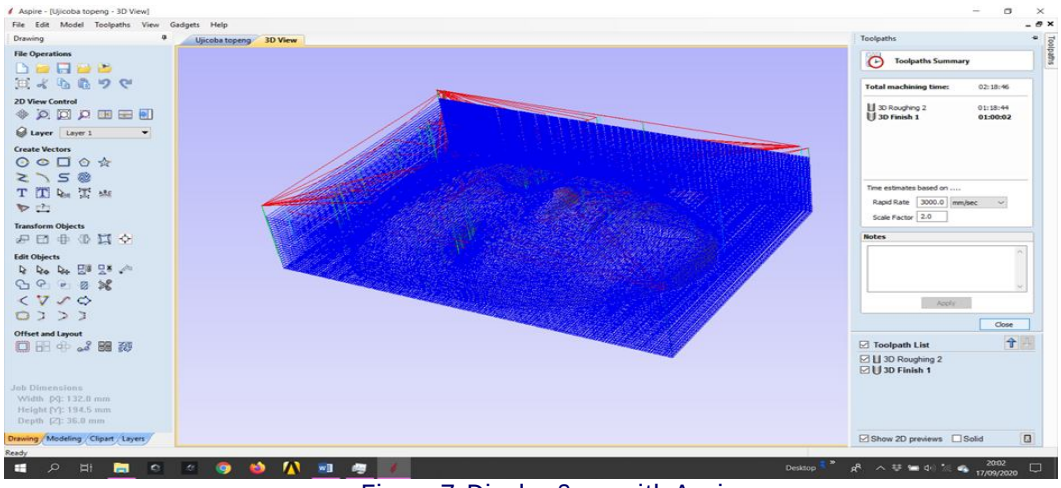

Figure 7. Display Save with Aspire

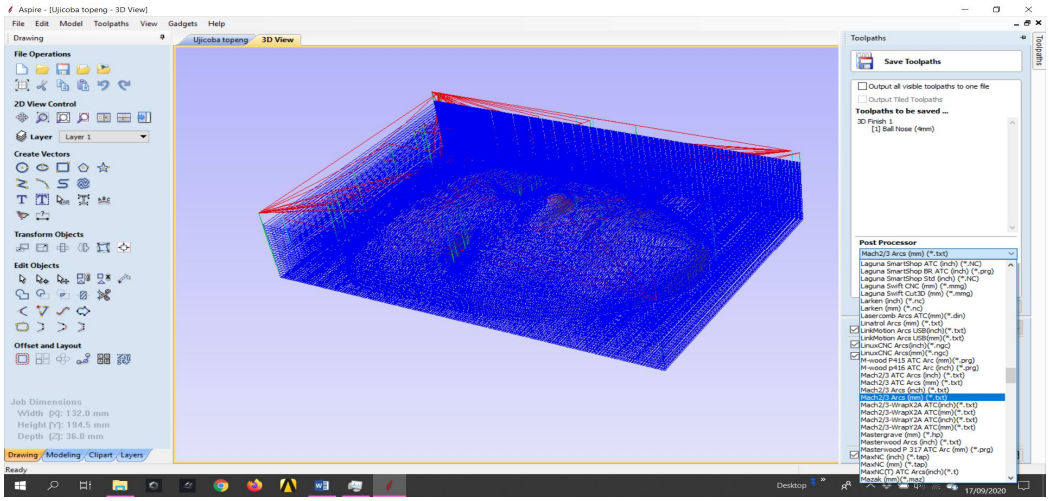

Figure 8. Aspire Program positions

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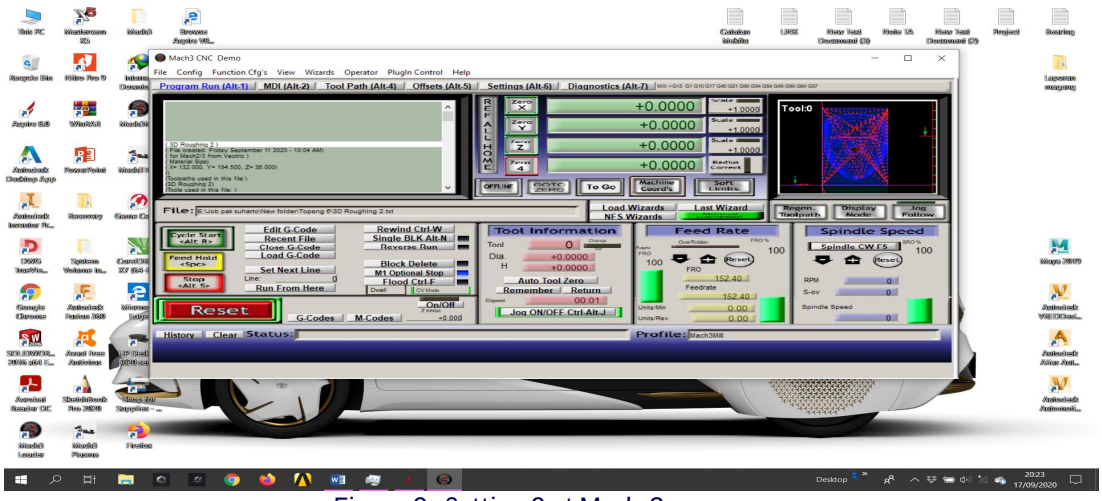


Figure 9. Setting 0 at Mach-3 program

## G. Setting objects on the machine

a. Setting the machine object, prepare the work piece on the work table with a clamp system that ensures it does not move during machining.
b. Mark the diagonal direction of the work piece to facilitate setting the accuracy and evenness of the work piece position.
c. Direct the cutting tool that is attached to the diagonal direction of the work piece.
d. Press cycle start to run the CNC Router machine.

## H. Result of machining process

Cangkring wood Mahoni wood Pule wood

Figure 10. Wooden mask

Table 1. Machining Parameters and Machining Time

| Specimens | | Machining type | Step over (mm) | Step down (mm) | Spindle Speed (rpm) | Tool flow | Machining time |
|---|---|---|---|---|---|---|---|
| Cangkring | I | Roughing | 4.56 | 1.5 | 12000 | Z Level Raster | 1 Hour 18 Minutes |
| | | Finishing | 0.4 | - | | Raster | 1 Hour 0 Minutes |
| | II | Roughing | 1.75 | 5.04 | 12000 | 3D Raster | 2 Hours 05 Minutes |
| | | Finishing | 0.76 | - | | Offset | 0 Hours 31 Minutes |
| | III | Roughing | 2.0 | 3.0 | 12000 | 3D Raster | 2 Hours 21 Minutes |
| | | Finishing | 1.0 | - | | Raster | 0 Hours 25 Minutes |
| Mahoni | I | Roughing | 4.56 | 1.5 | 12000 | Z Level Raster | 1 Hour 40 Minutes |
| | | Finishing | 0.4 | - | | Raster | 1 Hour 25 Minutes |
| | II | Roughing | 1.75 | 5.04 | 12000 | 3DRaster | 2 Hours 10 Minutes |
| | | Finishing | 0.76 | - | | Offset | 0 Hours 45 Minutes |
| | III | Roughing | 2.0 | 3.0 | 12000 | 3D Raster | 2 Hours 22 Minutes |
| | | Finishing | 1.0 | - | | Raster | 0 Hours 38 Minutes |
| Pule | I | Roughing | 1.5 | 3.5 | 12000 | Z Level Raster | 1 Hour 39 Minutes |
| | | Finishing | 1.64 | - | | Raster | 0 Hours 15 Minutes |
| | II | Roughing | 1.60 | 4.5 | 12000 | 3D Raster | 2 Hours 20 Minutes |
| | | Finishing | 1.5 | - | | Offset | 0 Hours 11 Minutes |
| | III | Roughing | 2.0 | 3.0 | 12000 | Z Level Raster | 1 Hour 02 Minutes |
| | | Finishing | 1.0 | - | | Offset | 0 Hours 55 Minutes |

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Based on table 1, it is obtained that the machining results are good for different wood materials. Pule wood material produces a wooden mask with a smooth surface and a faster machining time of 2 hours-07 minutes. Compared to the time and quality of manual manufacturing, the manufacture of wooden masks using a CNC router machine is faster and with better quality. In addition, the design and manufacturing files are well documented. Table 2 shown resume of machining time and Figure 12 shown machining time on 3 specimens.

Table 2. Resume of Machining Time

Specimens Cangkring Wood with time machining average (2hours-20 minutes); Mahoni wood (3hours-06minutes) and Pule wood (2hours-07minutes).

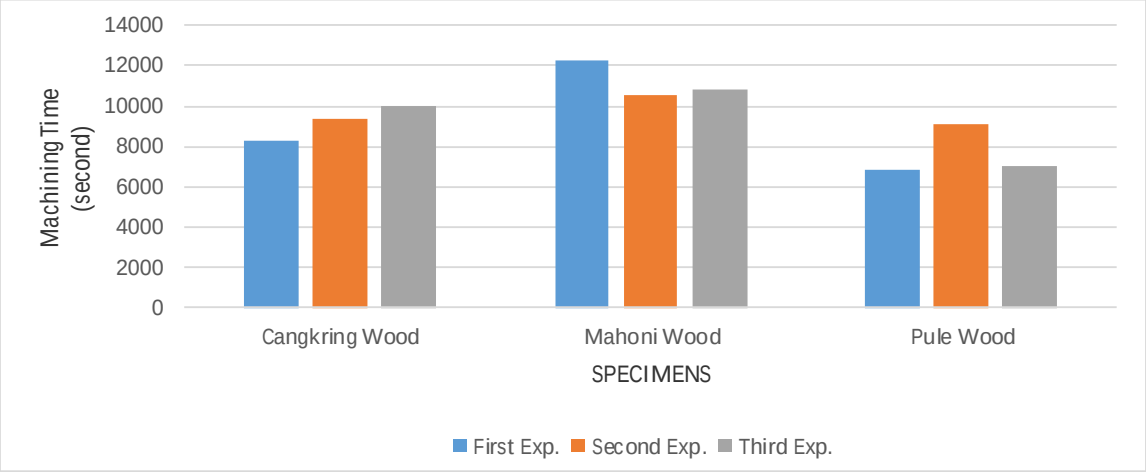


Figure 12. Machining time on 3 specimens

## IV. CONCLUSIONS

Some conclusions from the research results, as follows:

1. CNC router 3 Axis Technology can meet the needs of craftsmen wooden masks with better results, faster time, uniform size and shape. Time needed for pule wood (2 hours-07 minutes) cangkring wood (2 hours-20 minutes) and mahoni wood material (3 hours-06 minutes)
2. The machining process of a 3-axis CNC router for making wood masks is carried out in 2 stages, namely the Roughing process with the endmill tool ($Ø8mm$) and the Finishing process with the ballnose tool ($Ø\ 6\ mm$).
3. Best machining parameters for Pule wood material 12000 (rpm), step down 3 (mm) for roughing; step over 2 (mm) roughing and step over 1 (mm) finishing; toolpath selected 3D raster and offset.

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