MECH 4V96.004, Individual Instruction

Shop Design

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Mechanical Engineering

Eric Jonsson School of Engineering and Computer Science

THE UNIVERSITY OF TEXAS AT DALLAS

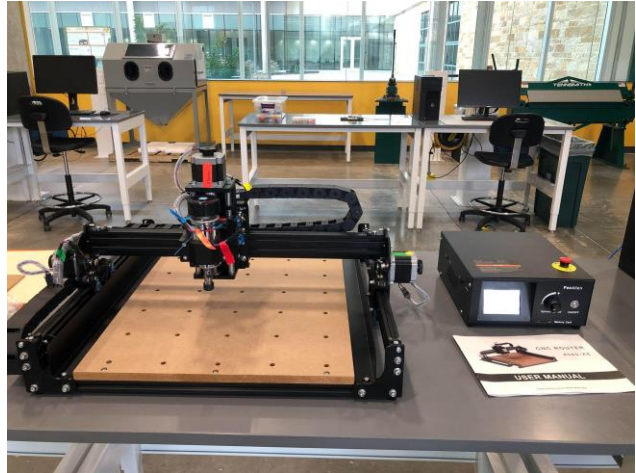## CNC Router Assembly

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Executive Summary

A CNC router, **FoxAlien 4040-XE 300W Spindle 3-Axis**, is assembled for general manufacturing use in the UTD project workshop. Basic operation and maintenance instructions were created while fabricating test designs.

Section 1, Problem Identification

The CNC Router is in the UTD project workshop and it is not assembled therefore unable to be used. The CNC Router does not come with clear and comprehensive operation instructions.

Section 2, Criteria and Goals

The purpose of this project is to assemble a CNC router for general manufacturing use. The criteria applied require the machine to operate consistently, have an operation and maintenance instruction, and meet the 6S principles. The goal is to have a fully-functional CNC router ready for use for any type of project that is done at the UTD Project Workshop.

Section 3, Research

The router purchased in the UTD Workshop is the FoxAlien 4040-XE 300W Spindle 3-Axis CNC Router. The machine was packaged with a set of assembly instructions and a list of parts in the box. There is also an online version of the manual found on the UTD Project Workshop website.

The video tutorial used to aid in assembling the router is found using this link:
https://youtu.be/igyscVKdOhU

More video tutorials are found using this link:
https://www.foxalien.com/blogs/news/tagged/4040-xe

The clamps provided with the machine pose a risk. The height of the clamps can interfere with the spindle especially if the material being worked on is too small. Solutions to this problem were addressed in the assembly tutorial video above. The proposed solution is to use painter's tape and super glue to fix the material onto the wasteboard of the machine.

https://www.homedepot.com/p/3M-ScotchBlue-1-88-in-x-60-yds-Original-Multi-Surface-Painter-s-Tape-2090-48CP/100550611

https://www.homedepot.com/p/Gorilla-0-71-oz-Super-Glue-78056/100661959

Section 4, Brainstorm

A Morph chart is not needed for this project. The test design to be fabricated was provided by Ning Bian, a PhD student and teaching assistant for Mechanics of Materials Laboratory. The design is a dogbone shaped test specimen commonly used for testing materials.

Section 5, Analyze Solutions & Develop Requirements

The requirements of this project are found in this table:

#	Requirement	Pass/Fail	Proposed modifications
1	Parts are complete		
2	Router is stable and sturdy		
3	Offline controller is functional		
4	Spindle spins		
5	Moves in x, y, and z axis		
6	Tape and super glue method to adhere material to the board		
7	Can engrave on material		
8	Can cut on material		
9	Final Design (Can fabricate a design)		
10	Costs less than $50		
11	Have operation instructions		
12	Have maintenance instructions		

Section 6, Develop & Test Models

The CNC Router Machine uses .nc files (Numerical Command) or gcode to fabricate a design. UTD Mechanical Engineering students usually work with CAD Programs such as AutoCAD, Creo Parametric, and SolidWorks.

For this project, we use AutoCad to generate our models and then we use an open source CAM software from OpenBuilds (https://cam.openbuilds.com/) to create the required gcode.

A prototype had to be made to test and learn how to engrave and cut on the CNC Router machine. Dr. Fadda provided an AutoCAD drawing of a UTD Mechanical Engineering Plaque to test the machine.

Problems encountered while creating prototype:

- The gcode generated did not have some key lines of code, one for the spindle instrument and another one for absolute position. (M3 S10000; G90).
- With a feedrate (x/y) of 1000mm/min, the spindle moved too fast which made the bit break.

- The depth setting was set at 2mm. We forgot to measure the depth limit of the v bit for engraving.

- Exporting the file to OpenBuilds was confusing due to the drawing having a 0 mm thickness.
- Exporting the file from AutoCAD between bitmap and DXF file also created confusion

In the end, the test design meets the requirements on Section 6.

#	Requirement	Pass/Fail	Proposed modifications
1	Parts are complete	Pass	
2	Router is stable and sturdy	Pass	
3	Offline controller is functional	Pass	
4	Spindle spins	Pass	
5	Moves in x, y, and z axis	Pass	
6	Tape and super glue method to adhere material to the board	Pass	A better adhering method to stop the material from vibrating during cutting
7	Can engrave on material	Pass	
8	Can cut on material	Pass	
9	Final Design (Can fabricate a design)	Pass	
10	Costs less than $50	Pass	
11	Have operation instructions	Pass	Finished along with the report
12	Have maintenance instructions	Pass	Finished along with the report

7, Make a Decision (CDR Presentation)

A CDR presentation was made on February 18, 2022 (2/18/2022), and the entirety of the Mech 4v96 class was present. The epoxy resin with 1% and 2% graphene to be cut was already in possession, and the production of the dog bones was approved by the entirety of the MECH 4v96 class.

The comments received during the CDR were:

- Explained why we needed to add extra lines on the generated gcode by OpenBuilds
- Explain on the need of superglue and painters tape

Questions asked were:

- How the painters tape and superglue were used?
- How to generate a gcode to fabricate design?

8, Communicate & Specify

The bill of materials is finalized. The meeting of the final design is scheduled.

Bill of Materials		
	Cost ($)	Quantity
Painters Tape	7.48	1
Super Glue	6.48	1
Rapid Fuse	4.67	1
Total	19.41	

9, Implement

The epoxy resin with 1% and 2% graphene was bonded down to the waste board, and the dog bone was cut with no pathing offset successfully.

Problems encountered during fabrication:

- Product material would shake and produce an inaccurate model if an insufficient amount of glue was used
- During gcode generation if the pathing option was not specified (no offset), The model would result slightly thinner than intended.
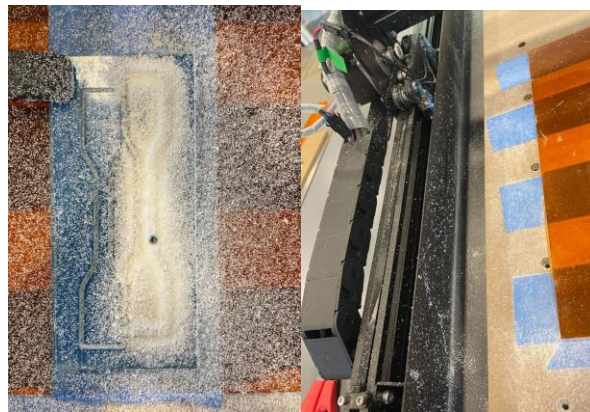

10, Review and Assess

The final product was cut and replicated two times after, as shown:

The dogbone met the expectations of PhD candidate, Ning Bian, and was taken by him on February 22nd, 2022.

11, Recommendations and Proposed Improvements

The CNC router can be really messy so wearing a face mask and/or gloves can be useful. The small material particles can be harmful for your lungs. Using gloves can keep your hands safe especially if you are working with metals.

The work area easily gets messy and dusty. FoxAlien provides a vacuum attachment on to the spindle. https://www.foxalien.com/collections/innovative-parts/products/dust-shoe-for-foxalien-cnc-router-4040-xe

The bits and tools did not come with an organizer. A toolbox for the bits will satisfy the 6S principles at the workshop

https://www.foxalien.com/products/laser-wizard-cnc-tool-holder?_pos=1&_sid=093060cfa&_ss=r

When cutting material, check the FoxAlien website and their tutorial page. They provide sample videos of cutting different types of materials. You can apply the same feedrate, plungrate, and bit types that they used.

https://www.foxalien.com/blogs/news