Special Thanks

- Campus Enhancement Foundation
  - Dr. Lucas Craig
- Nathan Spooner: Class of '24

3D Printer to Desktop CNC Conversion

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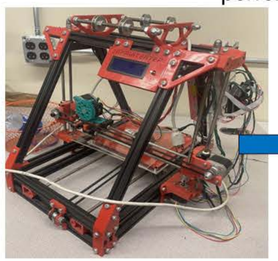
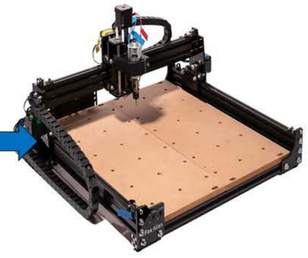
Dr. Lucas Craig, Mechanical Engineering Technology, Capstone 2023

Introduction

As hobby manufacturing tools grow in popularity from the creativity and independence of creators, an ever-growing amount look to repairs and cost-effective alternatives to products on the market currently. Instead of having an old and broken 3D printer, this project is a proof-of-concept and baseline for the conversion to a desktop mill that is competitive with the market today, both in cost and performance.



MendleMax 1.5 3D Printer.

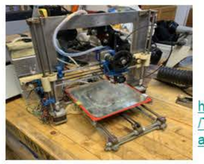


FoxAlien 4040-XE CNC.

Design Requirements

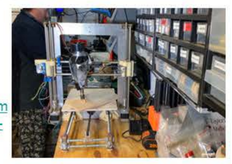
Needs	Wants	Like-to-Have
Cut materials 1/2" to 1" thick	Compatible with newer parts	Cosmetically pleasing
Speed rate of 12,000 RPM	Cost effectiveness	Simple to use
To cut soft woods, foams and soft plastics	Tolerance of +/- 0.1 mm (Theoretically)	Remote controlled

Background



MendleMax 1.5

https://www.instructables.com/Turn-an-Old-3D-Printer-Into-a-CNC-Machine

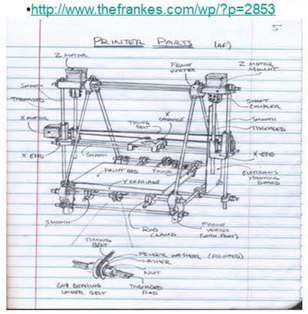


FoxAlien 4040-XE

MendleMax 1.5	Prusa i3	FoxAlien 4040-XE
	Size	
22" x 21" x 17"	15" x 15" x 13"	30" x 24" x 15"
	Design	
3D Printer modified for CNC milling	3D Printer modified for CNC milling	Dedicated CNC mill
	Cost	
$300 of Parts	$300 of Parts	$1000 for the whole assembly

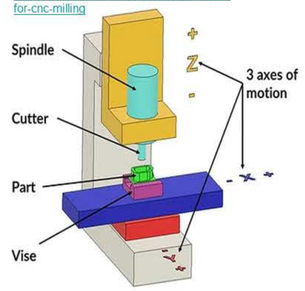
Terminology

•http://www.thefrankes.com/wp/?p=2853



Stripped 3D Printer

https://www.adambender.info/post/design-for-cnc-milling

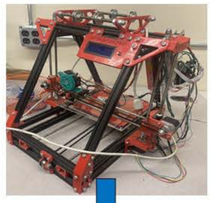


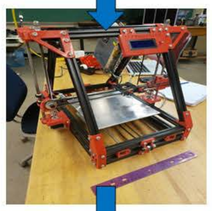
CNC Mill Components

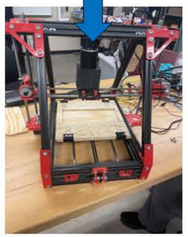
Capstone Objectives

- Convert the 3DPrinterTek (MendleMax 1.5) kit into a CNC mill
- Design, fabricate, and install the spindle to the x-carriage
- CNC a 3.5" x 8" x 1.5" piece of wood to ? shape and compare results to the FoxAlien 4040 CNC and maintain similar tolerances.
- Create poster presentation as well as a design report.

Preliminary Design







Initial Design: This image was taken on day 1 before any modifications had been done. All of the current 3D printer components were replaced since they couldn't run CNC software.

Phase 1: This is the CNC with all 3D printer-specific parts being stripped. This is the foundation of what we will build our mill. In this phase, we still needed to redesign the carriage system and build plate, software and other components.

Phase 2: In this phase, all CNC components have been added, including the spindle, control board, build plate, etc. At this point, we were left to improve upon initial designs and design a new axis belt system to better support our software.

Parts Selection

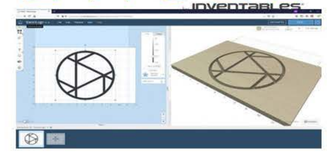
	Mother-Board Comparison	
	New	**Old**
Pros	Has the software needed for CNC	No purchased needed
	In-stock compared to others	Already wired and functional
Cons	Need to be rewired to work	Isn't functional with CNC software
	Most expensive out of options	

3018 CNC Router 3 Axis Control Board

	Spindle Comparison	
	Option 1 (208x52)mm	**Option 2 (200x52)mm**
Pros	Has a spindle speed control	Smallest size out of options
	Comes with power box	Cheapest option
Cons	Included mounting bracket may not be used	No included power box or speed control

CNC Spindle: Air Cooled Milling Motor

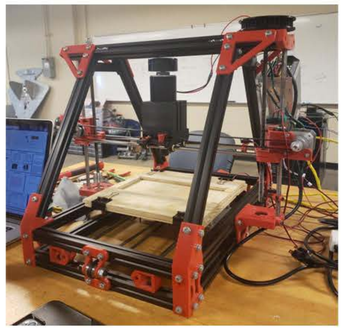
EASEL



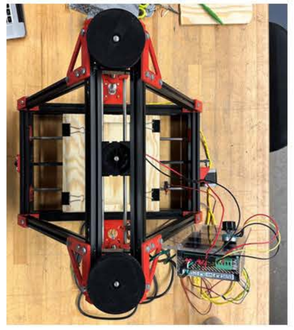
EASEL is an easy-to-use platform that lets you design and connect seamlessly to your CNC machine.

We chose this software over others such as Candle due to EASEL being an all-in-one software, able to produce the design and send the G-code to the CNC mill, whereas other software's only perform one of those tasks.

Final Design / Experimental Results



Side View



Top View

- The Easel program has only one slot for the Z-axis, but two are needed
- Removed one of the stepper motors in the Z-axis
  - Designed a gearing system to have one stepper motor control both Z-axis
  - Gearing system mounts to the top of the spiral rods in the Z-axis
- A belt will join the two axes together into one Z-axis

Project Contribution

Carter	Frank	Fred
Designed the 3D model for the printer	Stripped the printer to its bare form for reconstruction	Made the timeline for the project
Presentation	Presentation	Presentation
Measured the wooden board	Rewired the motherboard	Cut wooden base board
Attempted to programming w/ existing mother-board	Wrote the research proposal	Poster formatting
Parts Research	Parts Research	Parts Research
Found controller for CNC spindle	Assembled the spindle/power supply	Purchased specific screws
Found CNC program & sample code to run	Weighted parts objective table	Designed/Assembled mounting bracket

Lessons Learned

- Motor issues which required a design change
- Programming errors which required a change in program
- Easel program was designed for a spindle that moves in all directions, while ours only moves two and the bed is the third.