Project Conclusions

Overall, planning, designing, and developing the graffiti bot was a busy task while detailed measurements and time management were the most important factors. Initially to ensure our goals were met, our design team created a customer requirements list in which we ranked the importance from one another. Focusing on the drawing area capability (2.5'x2.5'), horizontal/vertical surface plotting capability, multi-surface drawing capability, accurate/ repeatability, and being lightweight. To approach these tasks, the techniques our team used included brainstorming conditional and promising design ideas at a low cost, reverse engineering 3D printer and CNC designs, and a Keep It Stupid Simple (K.I.S.S.) design process by focusing on reliability and precision. The work breakdown structure for our project broke up into a framework, movement assembly, and drawing mechanism categories. Moving forward into the concept evaluation phase, multiple products/materials were offered for the; frame, drawing medium, linear motion constraints, and motor drive. To evaluate these, our team carefully used a 0–100-point scale individually to weigh the importance of the requirements then took the average of each team member to come up with a final weight. Following this, we graded the design ideas as a team which concludes our choices of a wood frame, sharpie marker medium, shaft rods linear motion constraints, and GT2 belt motor drive which we all approved of. After gathering our materials and performing multiple make vs. buy tests for the wood frame, shaft rods linear motion constraints, and Arduino-CNC shield code system, our bill of materials concluded our cost to be $159.69. Beginning to generate our product, we created test plans which test our graffiti bot's accuracy and repeatability, marking tip durability, frame deflection (while drawing), drawing area of 2.5'x2.5', and product weight (<25lbs) in which they all passed. By passing all test plans and meeting the engineering specifications by December 15, 2020, we feel accomplished with how everything turned out.

Recommendations

1. Double check the quality of materials
   1.1. Specifically in this case the frame and linear shaft rods. Linear shaft rods were a little bulkier than the 3/8” specified. Frame faces on the wood 2’x4’ were rounded off which caused extra deflection and unevenness.
2. Re-evaluate design ideas for increased efficiency
   2.1. To minimize bend and deflection on the graffiti bot while drawing, we could improve this by mounting the x-axis motors onto the frame to induce weight on the linear bars as well as decreasing the size of the motor mounts so we can have further axis movement on the x and y-axis.
3. Include as much make vs. buy evaluations as possible
   3.1. In testing the plotting capabilities for the graffiti bot, we noticed one of the two x-axis motors weren’t working. To find out there was a soldering issue, purchasing motor cable extensions or making sure soldering skills are trustworthy would have been helpful.
4. Ensure mounts/load carrying capabilities are sturdy
   4.1. Setting up the 3D printed mounts that were planned to secure the GT2 belts on each end ended up failing as they were too thin. From this we should look over each fabricated part to ensure they are strong enough to hold any loads.
5. Create a strong base design
   5.1. While transporting the graffiti bot in and out of class we noticed there was some twist and deflection in our frame which could increase its chance of breaking. Including an outer wood frame all around to increase the strength of the frame would help solve this issue.
6. Re-consider different fabrication methods
   6.1. Fabricating multiple small pieces of wood for the motor mounts seemed to be more tedious and difficult than it should have been. 3D printing whole motor mounts instead of fabricating multiple small pieces of wood would have been less time consuming and left a more consistent finish.