Big 3D Printer

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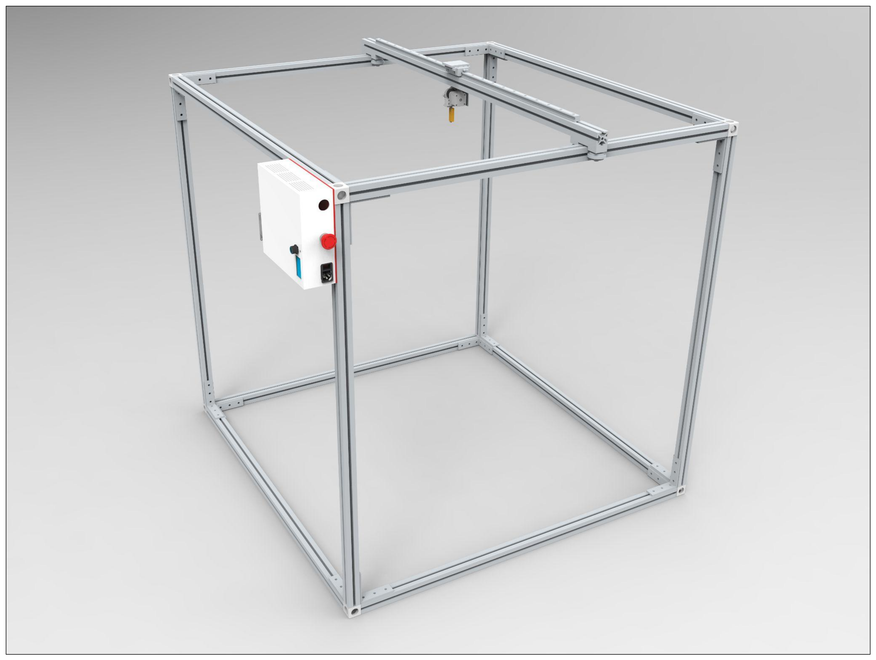
Problem Statement

The purpose of this project is to design and construct a large-scale 3D printer with a print area of 1 cubic meter. Using 3D printed components, consumer available electronics, and relatively inexpensive extruded aluminum, the final product should be as accessible to consumers as existing large-scale 3D printer alternatives.

Design Criteria and Challenges

The challenges in constructing a 3D printer are often universal, but the large target size requires different solutions to those problems. Given the target size of 1 cubic meter, extrusion speed was targeted at roughly 1 kg of filament/hr to keep prints within a reasonable completion time. Considered problems were:

- Power consumption
- Vibrations (from moving gantry and stepper motors)
- Extrusion (consistency and rate)
- Bed heating

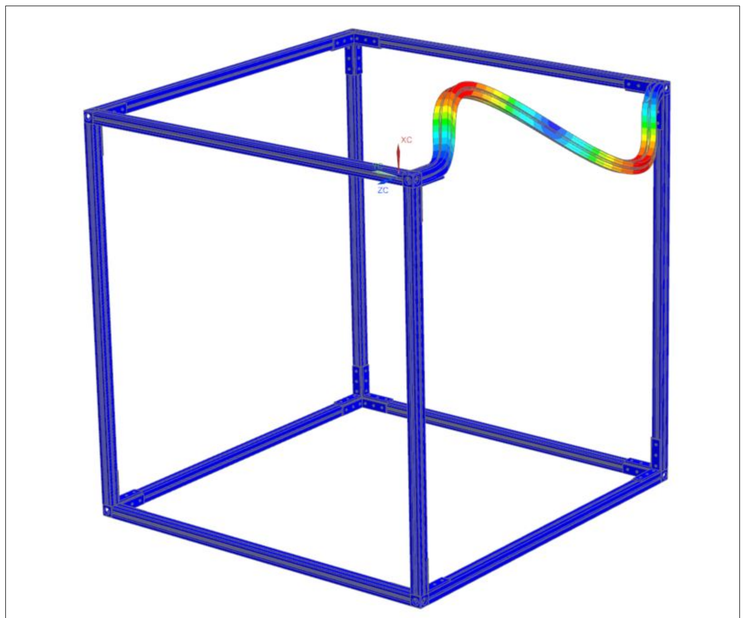


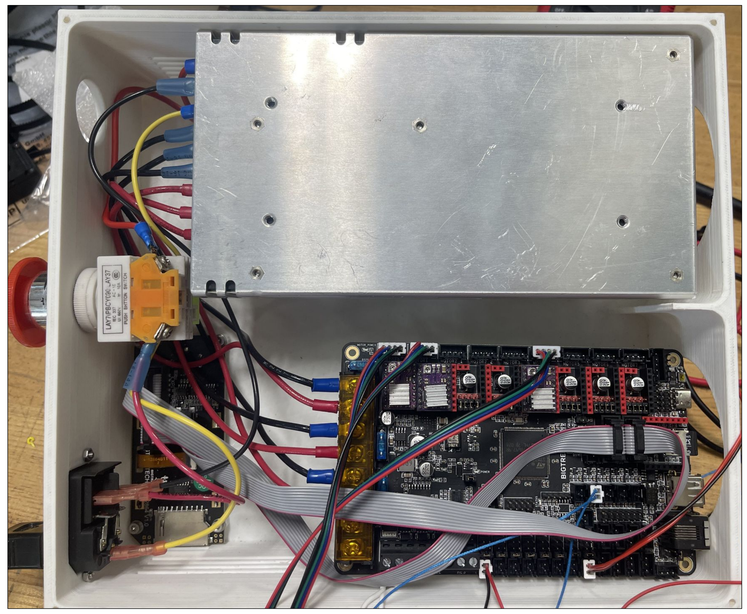
Project Expansion

This was planned as a two-year project due to time and budget constraints, therefore all systems involving the bed were excluded. Thus, discussions of the mechanical, electrical, and software systems exclude the functionality of the bed and any form of vertical movement.

Mechanical System

All models for the mechanical components were done in Siemens Solid Edge and all vibrational analysis was done in Siemens NX. Vibrational analysis was completed on the frame for 4 fundamental modal frequencies both with and without support brackets (right). The frame is constructed of extruded 8020. The XY gantry is constructed from an extruded aluminum support bar, linear rails, and a carriage. The corner brackets were able to reduce the vibrational amplitudes to a reasonable amount in the instance where the frequency affecting the system falls within an eigenmode.





Electrical System

All of the electronics are housed in a 3D printed box that can fit two Meanwell 350W 24V power supplies. A single BIGTREETECH Octopus control board is attached with DRV8825 motor drivers which power both the XY gantry's Nema-23 stepper motors and the Nema-17 extruder motor. The control board supplies power to the heating element for the hotend and other heating that would be used on the printer. The board offers support for additional sensors and heating elements that can be used for future upgrades on the system.

Software System

The control board utilized is the BIGTREETECH Octopus (right) running Marlin 2 firmware. A majority of firmware modifications have been to calibrate the system for the driver circuits and to convert to binary which can run on the STM32 processor. Extruder calibration has been done in firmware to validate print speed, as well as verifying simultaneous stepper motor control. The UI allows the user to control the system manually or to print a file from G-code, the universal standard for manufacturing.