Additive Manufacturing Using 3D-Printing

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HILLER MEASUREMENTS
inspired measurement design

Abstract

Hiller Measurements requested a mechanical design process to produce the internal chassis of their customized aerospace test equipment. The 3D printing team explored additive manufacturing to produce the generatively designed chassis using an MSLA 3D printer and photopolymer resin. The team improved production quality by standardizing support, raft, and print speed settings. Troubleshooting common 3D printing errors included reducing the effects of elephant's foot, minimizing peeling forces, and adjusting FEP film tightness. Post-processing involved exploring the effect of cure time on material performance by utilizing dynamic vibration testing and tensile & compression testing. Final assessments were made by considering the ease of assembly of all parts and holders. 3D printing was determined to be an effective tool for production when the parts are designed for manufacturing and when the material properties are in accordance with its desired functionality.

Background

Additive manufacturing is of benefit when it is efficient, functional, and cost-effective within the project scope. The desire to switch to a 3D printed internal chassis stemmed from the long lead time on the previously CNC machined design. Changing to the utilization of generative CAD software in the internal design, paired with 3D printing, allows for structural layouts previously unachievable with the previous manufacturing method. 3D printing also reduces cost and lead time on the fabrication of the internal chassis by making it manufacturable within Hiller's production facility.

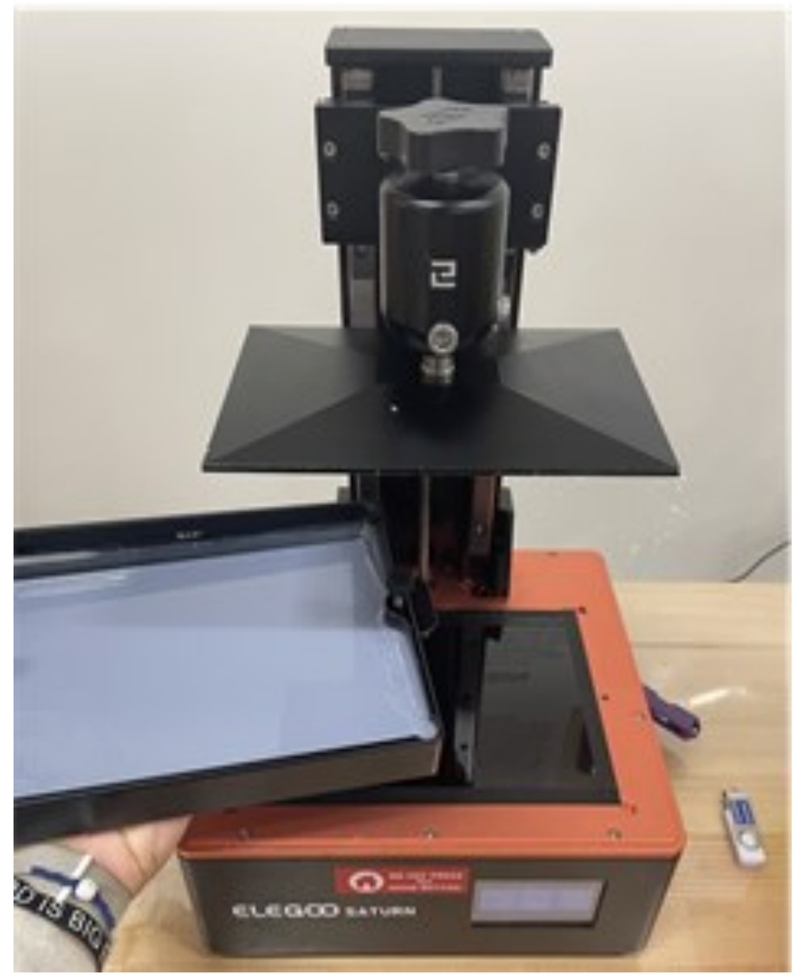

Figure 1: Print Station

Figure 2: Wash/Cure Station

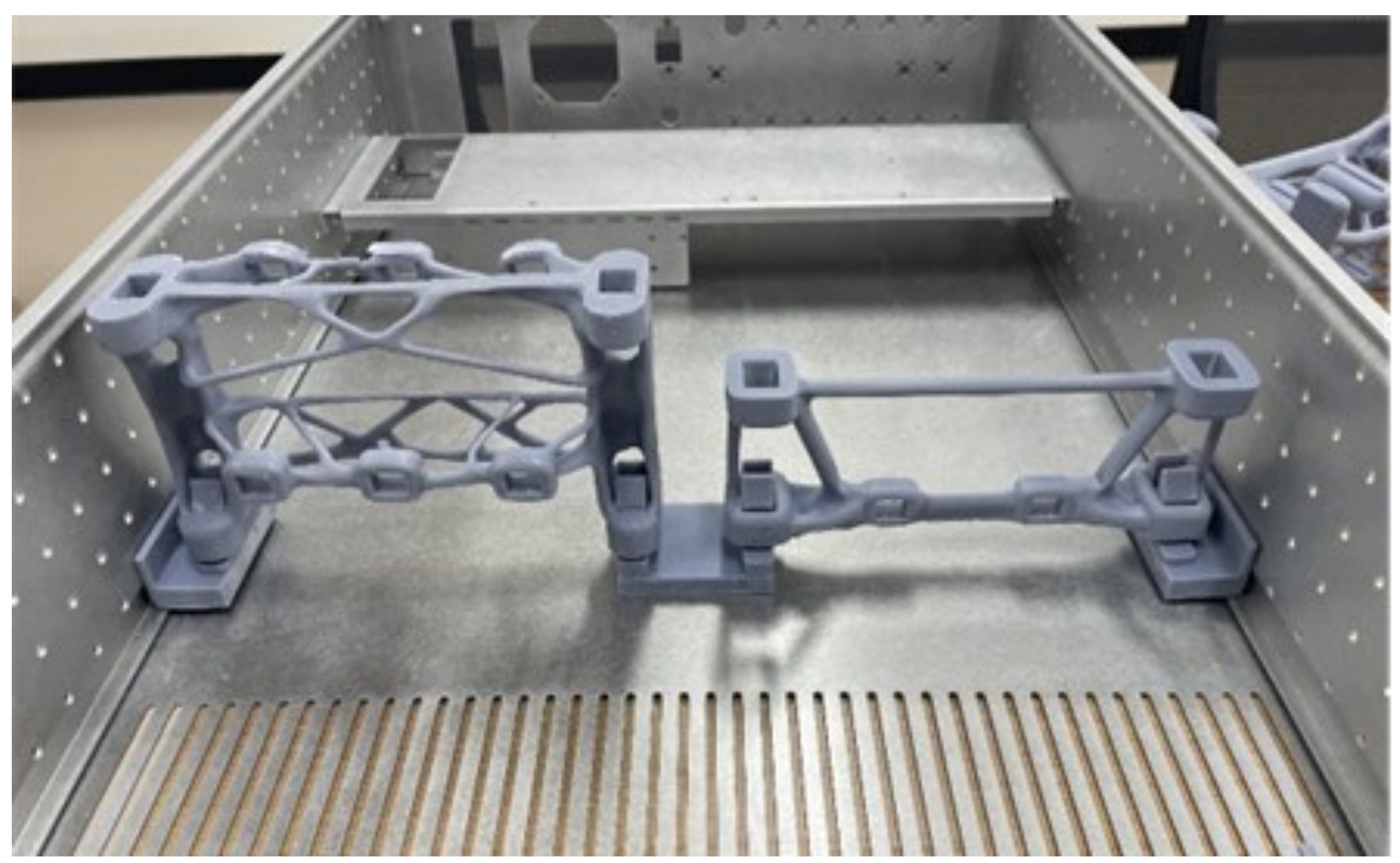

Figure 3: 3D-Printed Parts

Preparation

Once a part has been designed on Fusion360, the file must then be saved as an .STL file. This is because the slicing software only accepts .STL files. Chitubox is a type of slicing software. It takes any part and separates it into many different layers. This will show the user the entire print processes. After this, printing parameters are set. Printing parameters include how fast/slow the user wants to print, how much time each layer is being exposed to UV light, and how smooth the user wants the part. Once that is complete, the sliced file will be saved as a .ctb. Then, the file will be dropped into the USB drive and inserted into the printer.

Post-Process

Removal: Removal of print consists of dousing the entire print with alcohol, chiseling the print off of the build plate and removal of supports on the print. The materials needed during this process consist of Ethyl Alcohol 190 Proof, a chisel, and tweezers.
Washing: Washing that part is essential to a smooth and strong structure as this washing process removes any additional resin on the outside surface of the print. With the print off of the build plate, place the print into the cage and place the cage in the tub of alcohol. With the help of the Elegoo Mercury Plus wash and cure machine, the completion of the washing process is as simple as pressing a couple of buttons.
Curing: After washing, remove the cage from the alcohol and pat dry the print with a paper towel. The curing process utilizes the same Elegoo Mercury Plus machine. This process is effortless as the physical print is placed on the plate of the machine and with the push of a couple of buttons, the print will be cured for a specified amount of time.

Troubleshooting/Maintenance

As the project progresses, ware-and-tear on the printer can cause there to be issues with running the machine, decreasing the number of successful prints. Regular maintenance includes leveling the build plate to ensure prints are flush to the printing surface and changing the FEP film at the bottom of the resin vat. Changing this film can combat any stretching or knicks that would affect the precision of the prints. In a worse case, the machine can un-calibrate and prohibit anything from being printed cleanly due to the build plate not reaching the proper initial starting point. In that situation, a good first step is to recalibrate the z-axis. This allows the home position of the build plate to be reset and ensures it has proper contact with the FEP film at the bottom of the resin vat so that prints get proper exposure to the LCD screen in charge of hardening the resin into form.

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Hiller Measurements is a company that designs, manufactures, and support mission-critical tests systems, assemblies, and instrumentation for various defense centered companies. These chassis are often custom made and designed to fit the specific needs of the customer. The goal of the project was to cut down the lead time of the manufacturing and design process while also creating a one-of-a-kind product.