

Every year, engineering students from Cal State Fullerton (CSUF) work throughout their academic year in order to create their senior project for faculty and staff to view during their ECS Student Projects Showcase and Awards. Out of all the projects that were being presented, one standout was a group's design for a functional 3D printer.

All-In-One Modular 3D Printer

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INTRODUCTION

- Additive manufacturing, or 3D printing, is a process used to make three-dimensional objects by laying down succeeding materials under computerized control.
- 3D printers are an ongoing research and significant progress has been made in making 3D printers affordable and reliable for consumers.
- The versatility of 3D printers allows it to produce a wide range of objects:
 - Bio products, such as skin and functional organs
 - Prosthetic limbs for amputees, and even functional body parts
 - Edible foods: hamburgers and pizzas
 - 3D printed tools and food in space, (currently being researched by NASA)
- Currently, there isn't a 3D printer that meets the demand for consumers.
- In our research, the machine design being proposed can revolutionize the additive manufacturing industry that the world has been waiting for.

BACKGROUND

- As the need for an all-in-one machine is growing, 3D printers are becoming compact, while maintaining or printing at higher speeds.
- However, the cost to produce and market these machines are still too expensive for consumers.
- On the other hand, versatile or modular 3D printers offer more features and reliable printed parts.

DESIGN GOALS

- All in one printer, "Machine Shop"
- Small compact design for consumers
- Print multiple plastic materials (Ex: ABS)
- Milling machine
- Integrated 3-D Scanner; Structured light
- Carbon Fiber cutter (plotter)
- Passive Vibration Damping System
- Secondary Active Vibration Damping System
- Print at higher speeds
- Print high resolution parts

METHODOLOGY

- We used the Bowden extruder method to extrude the filament
 - Motor mounted onto frame
 - Reduces moving mass
 - Higher Print Speeds
- We used Lead Screws For Z axes
 - Self locking
 - No Vertical Brake
- Then we use Linear Guide Rails
 - Light Weight
 - Compact
 - Better Moment Loading
- And we used Arduino Mega
 - Inexpensive
 - microcontroller

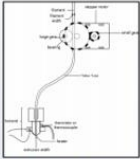


Figure 1: Bowden extruder

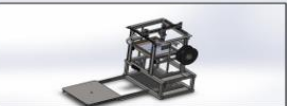


Figure 2: 3D model of final design.

RESULTS

Design Goals Results	
Design Requirement	Achieved Capabilities
All in one printer	P
Compact Design	P
Print Multiple Materials	P
Milling Machine	P
3D Scanner	P
Carbon fiber	P
Passive Vibration Sys.	P
Secondary Vibration Sys.	P
Print at high speeds	P
Print high resolution parts	P




Figure 3: Final stages of all-in-one machine.

3D SCANNER

- Laser 3D scanning vs structured light method

Table 2: Comparison of laser 3D scanning versus structured light method.

Laser 3D Scanning	Structured Light Method
Cheaper	More expensive
Much slower	Scaled to any size
Less precise	Needs to be calibrated
Size limitations	Better quality
A lot of noise	Precise scanning method

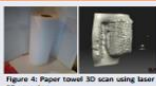


Figure 4: Paper towel 3D scan using laser 3D scanning.




Figure 5: 3D scan of statue using structured light method.

CONCLUSIONS

- Our all-in-one printer provides a small print area that consumers will like. The user will also benefit from the compact design that will save vital space.
- The developed structured light 3D scanner is compatible with 3D programs and other various programs that illustrates the usefulness of this all-in-one modular 3D printer.

ACKNOWLEDGEMENTS

Airwolf3D, Automation Direct, Quantum Automation, ME#2

The members of the All-In-One Modular 3D Printer consisted of Eric Butler, Jacob Dierking, and Joseph Romero each bringing in their own expertise into the final development.



The team's objective is to create an all in one printer that is compact and affordable while built for heavy duty industrial workers but also for the everyday consumers. Many applications in the industrial industry can benefit from a 3D printer such as creating tools and physical prototypes. They were also

looking to achieve printing at higher speeds along with better resolution for different types of plastic materials. This was seen as a must as the manufacturing process for creating reliable tools is a long and tedious process.

Quantum Automation graciously donated stepper motors, drives, and power supplies to help with the startup idea. The items donated are less expensive than industrial equipment they could have bought from other industrial suppliers, yet at the same time are reliable than purchasing them from hobby shop. AutomationDirect is known for having quality parts at a lower price. The motors, drives, and power supplies all have the durability and power as industrial grade components but still have the price that will not break their wallet. Also when asked how it was to integrate the



AutomationDirect parts into their design, it was a unanimous decision that the parts were simple and easy to install and program. Since they are looking to create a more affordable 3D printer, it would only make sense for them to use the Sure Stepper Motors, Drives and Power Supplies for the construction for the 3 axis design.

This massive undertaking by the CSUF students is about 80% complete. Quantum Automation has volunteered their efforts to technically support the Mechanical Engineering students to complete the alpha unit during the summer semester.