



# The Problems of Automating a 3D Printer for Public Vending

## Problem Analysis and Research



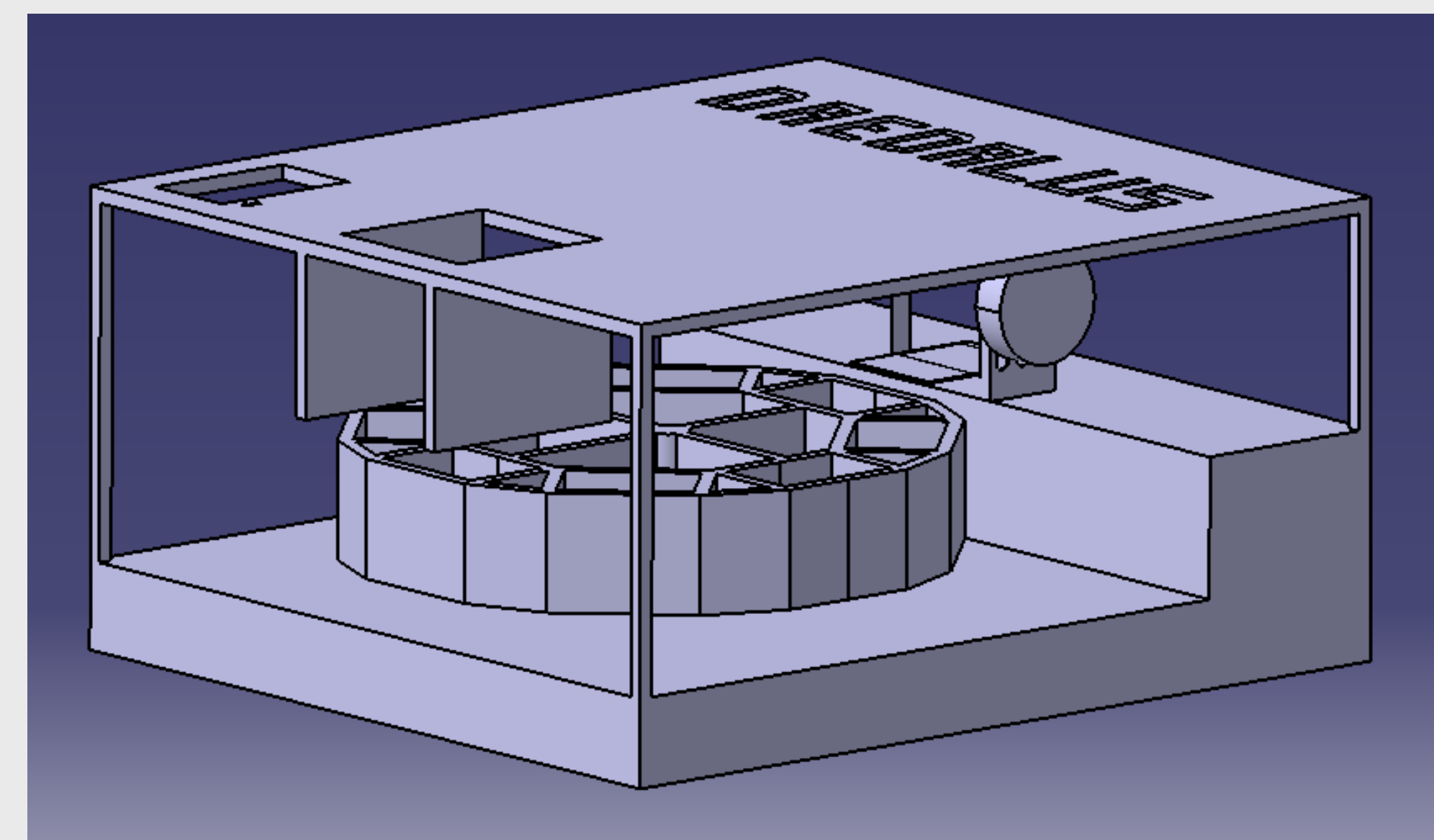
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### ABSTRACT

Advancements in technology have made 3D printing easily accessible to a large audience while maintaining the ability to create highly detailed products. Capitalizing on the higher demand for 3D printers, research and analysis on the problems that would need to be addressed in order to automate a 3D printer and have it function in a public setting have begun. Is it possible to automate a 3D printer so that it can function effectively and efficiently for public vending? The two main areas that the team examine are maintenance requirements and preventing possible errors. From there, many systems within the vending machine are analyzed to find ways to reduce human interaction and design a cost effective solution for that problem. The team proceeded to brainstorm solutions to each problem, refine the number of solutions by plausibility, and decide which solutions would integrate well with one another for the final design. As prototype designs are finalized, the team found that focusing on mechanisms that would lower regular maintenance are more efficient than complete automation. The designs include a linear actuator with an attached ramp to remove the finished print from the printer, a storage carousel to hold prints prior to removal, and a drawer to access the printer for maintenance. As the research finished, steps were taken to further automate the printer while streamlining the process of public printing through digital tools..

### INTRODUCTION

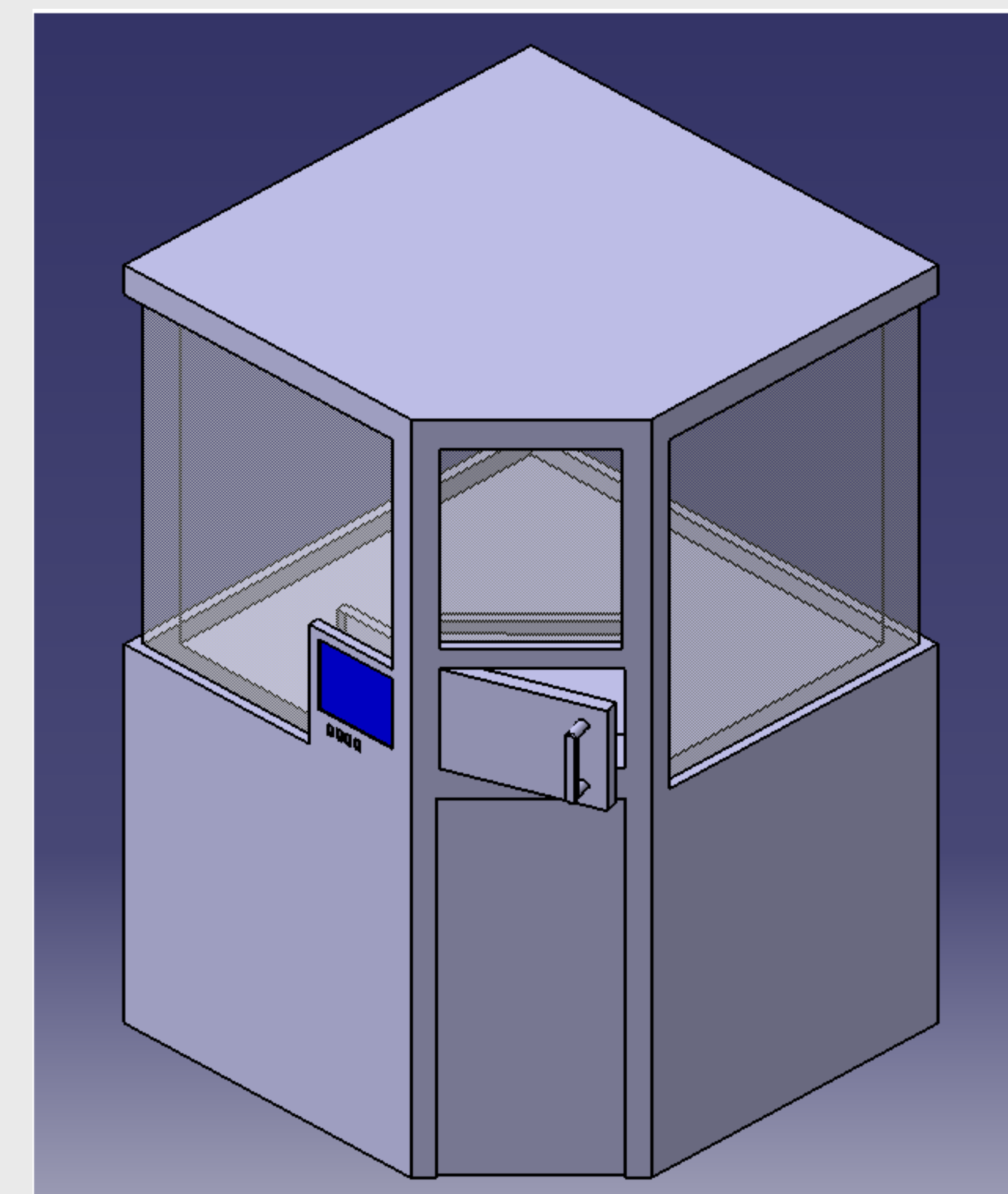
Project Daedalus is a student-led research project with the aim of creating a 3D printing vending machine for students to use. With the improvements to 3D printing technology in recent years, 3D printing is becoming progressively more prevalent both as a large-scale manufacturing process and as an accessible technology for individual use. However, despite the advancements in technology, 3D printing can still be quite an expensive investment for the average consumer. With this in mind, Project Daedalus seeks to take the level of accessibility a step further, by developing a vending system for a 3D printer, and making it so that the public (in this case, Embry-Riddle's student body) can easily upload designs to the printer, and then collect them upon completion. In addition to designing the vending machine, Project Daedalus intends to automate the system as much as possible, with minimal or no human interaction aside from the user uploading and collecting designs and any required maintenance. Hopefully, Project Daedalus will be able to create a marketable model for the system, although the system is still only in development.



**Figure 1:** This is an early design that was developed during the initial brainstorming of how to design our 3D printing vending machine. One of the main features that carried over from this was the storage carousel that holds completed parts safely and neatly.

### Methodology

- Before researching anything else, students examined maintenance requirements and error prevention for both a 3D printer and vending machine
- The team analyzed the internal systems of a vending machine to find ways to reduce human interaction with a 3D printer and design an effective solution for that problem
- To find effective solutions, the students brainstormed for a month, making rough sketches of the designs
- Solutions were decided on based on plausibility and how well they would integrate with one another for the final design
- As prototype designs were finalized, the team discovered that focusing on mechanisms that would lower regular maintenance are more efficient than complete automation
- The current design includes a linear actuator with an attached ramp to remove the finished print from the printer and a storage carousel to hold prints prior to removal
- The design went through a "roast," A.K.A. a product design review, using CAD to visualize the current design
- The team revised and improved the design, making minor changes to mechanisms
- added maintenance drawer to access the printer, solidified means of ordering and picking up printed parts, made printer more aesthetically pleasing
- Started putting real numbers behind calculations for electrical and began working on programming



**Figure 2:** This CAD image highlights the current design of the casing that will house the 3D printer, the storage carousel, and all other relevant mechanical systems. The blue indentation represents the interface used to interact with the system.

### Results

- A prototype design is currently in the process of being built.
- The material is cut, electrical supplies have been purchased, and programming has finished basic programs.
- As the research finishes, steps are being taken to further automate the printer while streamlining the process of public printing through digital tools.
- Will finish prototype within the month and work out kinks by end of semester

### Future Plans and Research

Reliability and service life are issues with some of the more well-known 3D printing vending systems, such as the Innovation Station or the Dreambox. These being known issues, the team looked into various low-intensity autonomous error prevention systems. For example, one of the main systems planned will actively monitor the printing process, and if an error is detected, it will halt the process, or, barring that, will notify a human operator of the error. Other systems will perform functions such as detecting and correcting miscalibrations between the carousel and the vending machine door, and document finished prints for comparison to the original CAD file to see if there are any printing errors. All of these ideas will allow maintenance operators to identify and thoroughly fix any issues that arise with the 3D printing system, and will also allow them to prevent such errors from occurring in the future.

### Conclusion

After researching the mechanisms and electronics that would be involved in creating an automated 3D printing vending machine system, the team determined that it would be nearly impossible to design an efficient, fully automated system that was capable of maintaining itself. However, while automating the maintenance processes would be excessively complex, automating the actual vending system would not be difficult, and the vending system has been designed as such..