1. Introduction

*Project Origin*

Single-use plastic manufacturing and consumption is accessible and cheap, making it an easy and attractive choice for the daily consumer. Additionally, because of COVID, single-use plastic use has increased even more in order to ensure health and safety regulations. With the growing concern of both the use of greenhouse gasses to manufacture the mass amounts of plastic products and the accumulating amount of plastic ending up in the landfills, the chemical industry is forced to pivot from traditional practices. Deloitte has identified three key options for chemical industries: “alternative sourcing, improved recycling technologies and sustainable disposing of plastic waste, and achieving a circular economy.”

Our senior design project aims to repurpose the plastic bottle use on campus by simulating, designing, and ultimately building an extruder that can take plastic bottles as the input and produce Fused Filament Fabrication (FFF) 3D printing filament as the output. The most popular and common 3D printing filament is polylactic acid (PLA) and acrylonitrile butadiene styrene (ABS); however with our extruder, we will be able to generate an alternative source of filament – polyethylene terephthalate (PET) filament.

This project also achieves a circular plastics economy on Vanderbilt’s campus, through our partnership with the recycling division of Vanderbilt Plant Operations (VPO). VPO provides us with the plastic bottles, in which we are able to process into 3D printing filament that can serve many labs and makerspaces across campus, such as the Digital Fabrication Lab, the Wondry, and the Design Studio.

*Goals and Deliverables*

Our goals for this project were to use simulation to determine key design parameters, validate throughput values to prove the mechanical feasibility of filament production, design and size an entire Computer Aided Design (CAD) model of the extruder using Fusion 360, and finally, build a working prototype of the extruder. As a result of the goal of building a working prototype, more specific goals and deliverables are defined as follows:

* Establish a partnership with Vanderbilt Plant Operations for future senior design groups to continue using recycled bottles as plastic bottle source
* Create a standardized method for converting plastic bottles into regrind flake and document these steps in SOP form
* Determine barrel wall thickness using Barlow’s Law
* Determine screw parameters and motor rating from NEXTRUCAD
* CAD and assembly entire extruder
* Determine material properties of rPET filament product

*Scope*

The scope of this project was to design and create a working prototype rPET extruder and develop a method to process PET bottles into regrind. We have considered a hypothetical large-scale manufacturing environment in the Process Economics section.

*Gantt Chart*