The concept of Plastofuel™ is the use of waste agricultural plastic as a fuel source. The Plastofuel™ process creates a dense plastic nugget of compressed shredded plastic that can be burned cleanly in a high temperature combustion process. The shredded plastic is composed of high- and low-density polyethylene, polypropylene, and polystyrene.

The most recent prototype of the Plastofuel™ machine utilizes a hydraulic pump to power a piston which forces a solid plunger through a hollow steel cylindrical cannon. The two-and-a-quarter-inch-diameter plunger goes approximately eight and a half inches into the hollow cannon to force the shredded plastic through the entire length of the cannon, which is 30 inches. The condensed shredded plastic is heated in the last nine inches of the cannon by band heaters around the outside of the cannon. These band heaters are controlled by a thermocouple set to maintain a temperature of 200 °C. The heating produces a thin melted layer around the outside of the material to preserve the compression achieved inside of the cannon. The Plastofuel™ product exits the cannon as a porous solid cylindrical piece, as shown below.

Our task was to increase the density of the Plastofuel™ product by 30%, while continuing to minimize the energy consumption of the process. Our team chose to design a tapered nozzle to attach to the end of the cannon. The nozzle will also provide a short section of cooling, as the band heaters will remain at the end of the cannon and not surround the nozzle, as shown below.

A 49% increase in density was achieved, exceeding the target of a 30% increase. Our design altered the end of the cannon by reducing the inner diameter from 3.125 inches to 2.9 inches, with a straight taper at 45° beginning 3 inches from the end of the cannon. This diameter change corresponded to a 20% reduction in the cross-sectional area of the product.

The increase in density was achieved without changing the feedstock, the pressure of the hydraulic pump, the amount of heating, or the heating temperature. The void space in the product was reduced from 55% to 33%. A product with a higher density is desirable because it would reduce the amount of volume needed to store and transport the fuel.