Shell Eco-Marathon (Team 2) – Redesign of the Prototype Vehicle Canopy Using Innovative PET-G Fabrication Process

The Problem:
Shell Team 2 was tasked with the design and manufacture of a new canopy for the Penn State Shell Eco-Marathon Prototype vehicle. The original canopy was fatigued, limited driver visibility, and had been damaged from continued use. It was Shell Team 2’s goal to design and fabricate a canopy that addresses these current issues and the researched needs.

The Unique Solution:
Shell Team 2 utilized an innovative manufacturing process to create a product that best addressed the identified project needs. This project, referred to by the group as “Vacuum-less 2-D Mold Air Forming”, allowed the group to quickly prototype and create a strong, repeatable 3D canopy shape that did not limit driver visibility. Additionally, the process required minimal set up, which saved labour time and reduced fabrication costs.

The Process:
This process, to the group’s knowledge has only ever been done twice before ever, both times here at Penn State. In essence, the process is very similar to the fabrication process for any plastic water bottle, with the exception that no 3D female mold is utilized to control the final shape. A sheet of PET-G (Polyethylene Terephthalate Glycol) 0.090” thick was sandwiched by two plywood sheets. The top sheet was kept solid, except for a small hole for an air nozzle, while the bottom plywood has a 2D female shape, as determined with SolidWorks, cut into it. Legs were added to one side of the mold. Sealant tape was used to seal the PET-G to the plywood, and drywall screws were used to fasten the whole mold together. The mold was then put in a large oven and heated to approximately 280 °F for 15 minutes. Then, pressurized air (~60psi) was fed into the aforementioned nozzle, which resulted in the PET-G blowing downwards, like a bubble. Once the desired shape was acquired, the mold is removed from the oven, with constant air pressure being fed to the mold. Once the mold cooled, the plastic PET-G hardened and was removed from the mold. After it was removed, the canopy was trimmed to size and fitted with necessary hardware to fit the vehicle.

The Conclusion:
Shell Team 2’s project was successfully completed on time and under budget. The team spent approximately $980 of its provided $1000 budget, while using the full 15-week semester. Two prototypes were made, both to varying degrees of success. While the first prototype was too shallow to properly fit the vehicle, the second canopy was quite nearly the perfect shape and size. Although there was some minor irregularities in the surface finish of the second canopy, due to some manufacturing issues, the second canopy was trimmed mounted to the prototype vehicle. Shell Team 2 feels that this project was both objectively and subjectively a success.