SPE THERMOFORMING DIVISION'S SECOND ANNUAL STUDENT RC CAR RACE AND DESIGN COMPETITION HELD IN MILWAUKEE

Thirteen students from seven schools across the U.S. were charged with designing, manufacturing and decorating the bodies of radio-controlled cars whose chassis were furnished by the Division, with support from corporate sponsors. The car body had to be formed using clear plastic, such as PET, PETG, acrylic or polycarbonate, and produced using the vacuum/thermoforming process.

Students also participated in a race conducted on a built-to-specification indoor racetrack located on the exhibit hall floor during the Thermoforming Division's annual conference, held September 9-11 in Milwaukee, WI.

Cash prizes were awarded in three different categories: People's Choice, Best Design and the race itself. Zachary Veneziano and Ryan Messock of Kettering University won second place in the race behind Ryan Fuller of Georgia Tech.

The Kettering Bulldogs were sponsored by LyondellBasell.

Student participants were required to submit a technical paper that outlined the successes and challenges associated with the car design and manufacturing processes. Following is Zachary's and Ryan's report:

Pictured from left to right: Matt O'Hagan, SPE Thermoforming Division Student Activities Chair; Zachary Veneziano and Ryan Messock of the Kettering Bulldogs, Kettering University.

Design

The Kettering University SPE Student Chapter began the design process by first looking at which thermoformed bodies won in the inaugural year of the event.

Bodies that received praise from the judges had lots of small details that showcased the thermoforming process. A complex design led to a more complicated mold design, which was something that was kept in mind during the initial design phase. Chapter members were unsure of which manufacturing process would be used to create the mold. During discussions about the shell design, we agreed to make the shell look like an Audi R8. The reason for this decision was because a mold of this car body would have plenty of exterior details that would hopefully help in the design competition when the shells were judged on complexity and uniqueness.

We also hoped that designing a shell from an existing car body would attract the attention of the conference attendees who would recognize the car and win points in the People's Choice Award. After the shell design was finalized, team members used Solidworks 3D modeling software to create a model of the mold.

Mold Manufacturing

The team brainstormed ways to quickly and inexpensively manufacture the tool. The original idea was to CNC the mold out of wood; this, however, proved costly compared to a 3D printed mold. It would also preserve as much detail. With a printed mold, detail in every axis could be present without requiring multi-axis CNC machines that would be needed if the mold had been made from wood.

The team worked with a 3D rapid prototyping company in Ann Arbor to ensure the CAD model was printed without any major issues. Next, a material was chosen that would work best for the project. Because the mold was going to have hot sheets of plastic formed over it, the decision was made that the print material should have as high a melting point as possible. The team selected ABS as the print material since it has a melting point of approximately 400°F and the heated PETG that would be formed over it only has a melting point of 300°F.

The team thought that this temperature disparity would prevent warping of the plastic mold when the two plastics came in contact with each another. After the material was chosen, the final design was sent to the prototyping company. The print project took 68 hours to complete, and it resulted in a 5mm thick shell that would be used as the mold.

Forming

The Kettering University Mechanical Engineering Department owns and maintains a MAAC thermoforming machine, and it was used to form the RC car shell. The team placed the mold in the machine and began running trials in order to work out the kinks in the process, produce parts that looked good and preserved the details of the design. During this grooming process, several issues occurred that hindered the forming of good parts. The first issue was that the PETG sheet was allowed to heat for too long, resulting in significant sagging of the sheet. This resulted in the heated sheet running into the mold during the first trial, ruining the sheet. This issue was corrected by turning the temperature control down to reduce sagging. After this initial correction, the heated sheets were forming around the mold, but not sealing. In order to correct this, a plug was used that allowed for better sealing around the mold and for some adequate partsto be formed.

While the parts coming off of the machine maintained the details of the mold, webbing still occurred at the edges of the shells. This issue was only resolved after more temperature controls were adjusted, as well as heating times. When these were dialed in correctly, good parts were made that showed all of the details of the mold without any webbing or unwanted features.

Issues

During the grooming process, one major issue occurred that set the team back significantly. While conducting trial runs, the mold was left to sit next to the heater block for too long, which caused warping of the mold. When choosing ABS as the mold material, the meat of the PETG sheet was taken into consideration, but the heater blocks were not. The heater blocks were only an issue if the mold was allowed to sit directly next to them for extended periods of time; however, the damage to the mold was already done, so additional work was necessary. Bondo was used to reform the damaged back end of the mold, and after lots of sandpaper and buffing, the mold was smooth and worked as well as it had before the damage occurred.

Another issue that the team encountered was with the tires of the RC car hitting the overhanging wheel wells of the thermoformed body. This turned out to be a significant issue for the race, as the unintended rubbing hindered the steering of the car, which affected race performance. To overcome this issue, the team decided that it would be best to bring two bodies to the SPE Thermoforming Conference: one would act as a show body, and the other as a race body. The show body would be used to showcase the thermoformed details of the car, and the race body would be identical to the show body with the exception of the wheel wells, which were cut out to allow for a better turning radius. This solution proved simple yet effective, as only a few details were cut away in the race body and the cuts allowed for significantly better steering and handling of the RC car.