Project Summary

The project’s objective was to design and build an active device that regulates the airflow between the grille and radiator of a Volvo VNL series truck. The device’s control over the airflow ensures several benefits such as: improved aerodynamic and fuel efficiency. In addition, the team set their own internal aim of developing a device that could match or exceed Volvo’s competitor’s solution (Mercedes Actros). Following an initial research on airflow control and competitor’s products, the group utilized the given engineering specifications to develop a list of customer needs. In specific, functionality, safety and durability were determined to be the three most important parameters. The initial research also aided the team members brainstorm 12 concept ideas which were evaluated through a number of concept evaluation matrices like the Pugh matrix. These matrices evaluated the concept ideas based on their fulfillment of the customer needs. The matrices’ results streamlined the ideas to a final concept: the “Modified Actros”. This design represents a modified version of the Mercedes Actros. The modifications focused on features such as the blind design, the frame design and the actuator.

Following, the team conducted additional research to obtain valuable information and inspiration to create the designs for both the frame and the blinds and to select the actuator. The research’s results aided the team to design an hour glassed shaped blind, whose thickness varies between 1 and 6 mm. This peculiar shape was selected for the blinds because it ensures higher overall part strength, it facilitates its connection to the frame and it guarantees symmetric and constant airflow. The team selected to design a squared frame that contained internal ribs. To increase manufacturability, the frame was divided into three individual parts: two side bars and an I shaped middle bar (spine). Lastly, the team followed the sponsor’s recommendation and decided to utilize PM DM active grille shutters as the actuators. After completing the design of the 3 dimensional model on CATIA, the group conducted several simulations to analyze the performance and effectiveness of the model. The finite element analysis determined that the blinds experienced a 4mm deflection. The flow simulation indicated that the current blind design only caused a 10 % airspeed reduction. In addition, the team calculated the device’s surface area sealing and open percentages to be, respectively, 94.8 and 90.7 %. Subsequently, the team sent the model to Volvo for evaluation purposes. At the same time, several details regarding the final product were finalized. Most notably, the group determined that PA type 66 with 33 % glass fiber would be right material for the final product. The model evaluation conducted by Volvo revealed that our model required further redesign to facilitate 3D printing and mounting. Based on Volvo’s feedback, it was determined that the prototype could not be 3D printed by Volvo and shipped to Penn State in time for the showcase. Thus, the team