Toyota Door Auto-Oiler

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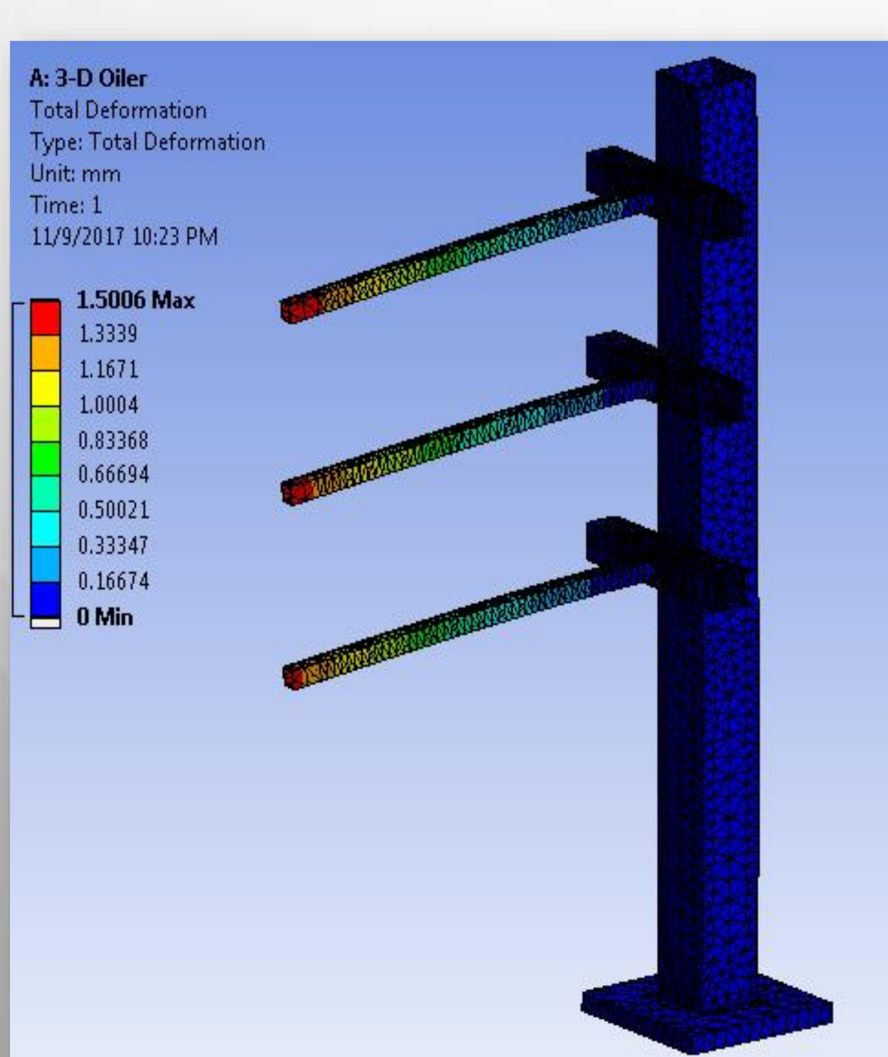
Introduction

The goal of this project was to create a system that covered a car door in oil as it passed down the assembly line at Toyota in Georgetown, Kentucky. The biggest concern while designing this project is for safety, which happens to be Toyota's main focus. The system needed to have controlled movements and a minimal number of pinch points. It was also important that the system followed OSHA requirements, which would address some other safety concerns. Second most important is the functionality of the system. It needed to apply a thin layer of Cupran oil evenly to the entire door with minimal waste. It should also be easily recreated in a mirror image as this would allow the system to function for both sides of the car.

The Georgetown facility builds two different body styles, so it is also important that the system is flexible and can be used for different door profiles. This concept can be extended to many other vehicle styles at other plants if the system proves to be successful. There are also a few physical requirements for the system; for example, it must be at least 500 millimeters from the moving assembly line. Additionally, the whole system must fit within the current assembly line and it must not cause any damage to the vehicle as it passes. Toyota has requested that the system body have the same lifespan as a car, but the applicator portion of the system may be replaced bi-weekly at most, as long as it is simple and cheap to do so. These requirements must all be met within a maximum of a $10,000 budget.

Analysis

For this design, a structural and fluid analysis had to be performed. Each of these required minor testing to begin the process. To ensure the devise was strong enough to withstand the various forces it would endure, the design was drawn into Ansys Workbench and run with finite element analysis. The forces added were the weight of the pad (when fully loaded), the pressure of the vehicle against the pad (which when tested was two pounds), and the acceleration due to gravity (to account for the weight of each piece).



ANSYS Analysis of the Beam Structure

Fluid analysis began by obtaining the Material Safety Data Sheet (MSDS) for the Cupran Oil that would be used in the apparatus. From this the density of the fluid could be calculated and used to determine the required pressure needed to obtain the optimal fluid flow throughout the height of the devise. The amount of liquid used for each vehicle was determined by calculating the application surface area and the thickness of the layer of oil. The last test that was performed for fluid analysis was to determine the viscosity of the fluid. This was done using a viscometer and would account for any losses inside the tubing of the auto- oiler.

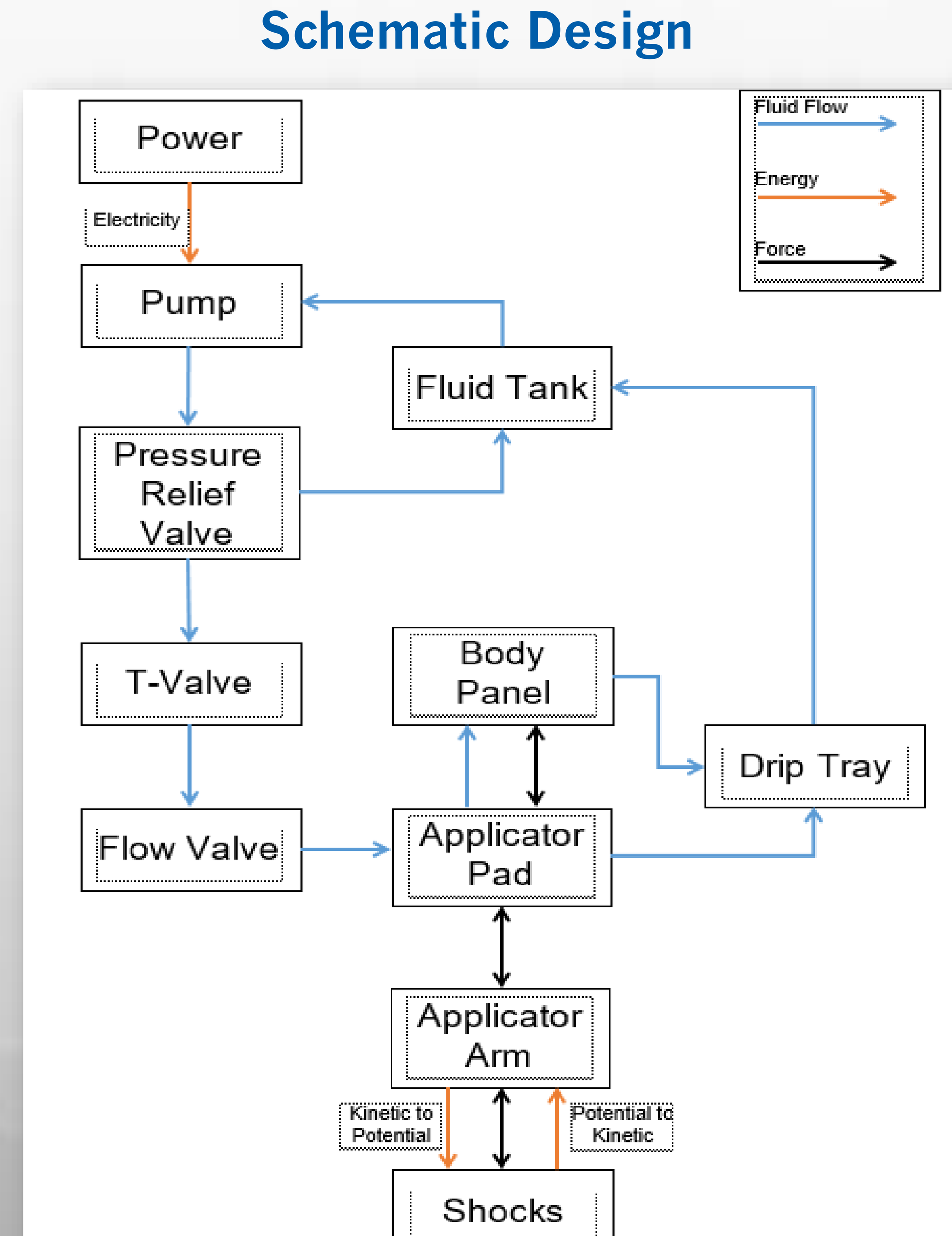
Final Prototype

The prototype will be made up of the ordered parts listed on the material list. It will be put together as shown in the CAD drawings shown. The tower will be bolted to a steel base plate acting as a base stand for the apparatus. This steel base plate will be heavy enough to keep the tower and arms upright, even with the amount of force the car will exert on the system.

The extruded aluminum arms will connect to the extruded aluminum base using t-slotted hinges and bolts. They will attach to the front side of the aluminum tower and the bottom side of the arms, in order to support the arm's weight and keep them connected to the tower. Next, the memory foam piece will be attached to the arms using Velcro on the back of the foam and the front of the arms. Microfiber cloths will be wrapped around the foam piece in order to evenly spread the side of the car as it passes by the apparatus.

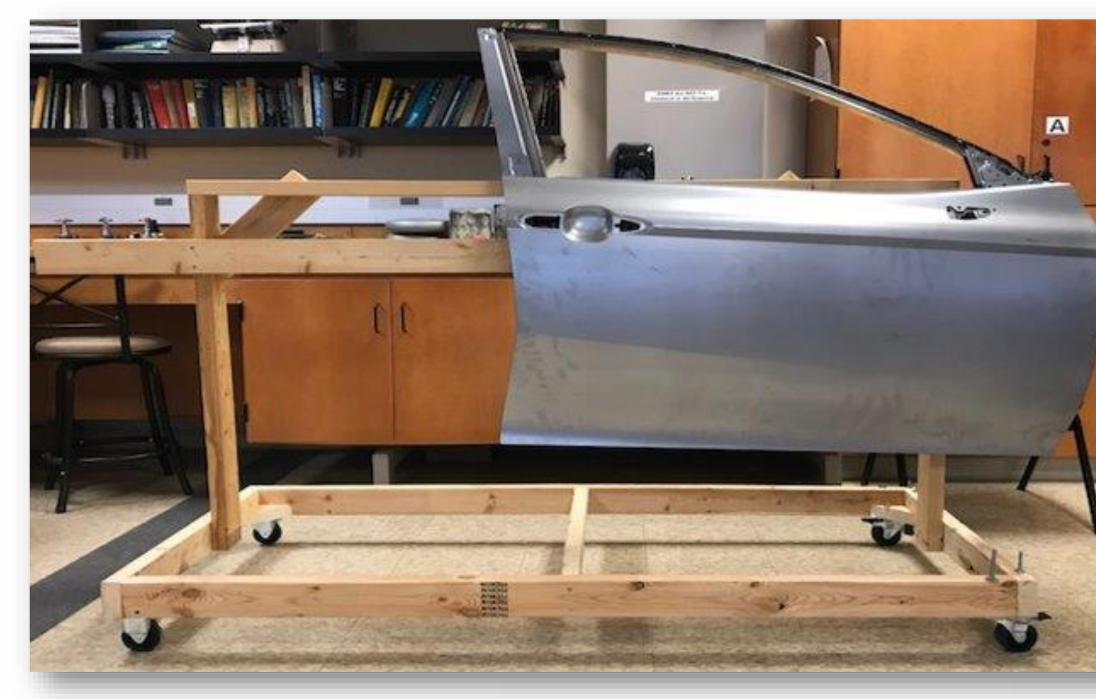
A tank of Cupran will sit at the base of the apparatus and plastic tubing will be run from the tank to a pump. From the pump, the tubing will run up the aluminum tower and split to each arm individually. Once the main tube is split for the three arms, flowmeters will be attached to each individual tube in order to adjust the flow rate of the Cupran. Once through the flowmeters, the tubes will run to the top of the foam/microfiber applicator so that the Cupran can flow down the cloth. This will allow the cloth to have a constant flow of Cupran down it as it wipes an even layer.

Schematic Design



Prototype Testing

As far as testing the prototype, the system will be assembled (as discussed before) and be placed on a spot of the floor in the University of Kentucky's Ralph G. Anderson Engineering building lab in a manner that will simulate how it would sit on the side of the assembly line at the Toyota Factory in Georgetown, Kentucky. Two car door will be attached to the side of a cart and tracks will be built in order to maintain a straight line as the cart moves. The cart will then be moved past the assembled auto-oiler in order to simulate how the car would move past on the assembly line.



Camry Door for Prototype Testing

Once the car doors pass by the auto-oiler, the amount of Cupran will be analyzed in order to determine if an appropriate amount of Cupran was wiped in a sufficient film thickness across all parts of the door, in order for the inspectors at the next stop on the assembly line to catch defects. The Cupran can be easily wiped off the doors so that they can be used to run multiples test as needed. Small things will need to be tweaked or modified here and there in order to meet the requirements of Toyota.

To test fluid flow there are various factors that will be tested. The factors include pressure from the pump and application method. There will be one pump that supplies the three arms, so the pressure and valves on each arm will need to be adjusted so each arm applies an adequate amount of oil to the surface. Current methods of fluid application that will be tested are a squirting method and a saturation method. The analysis will be done to determine if the oil is applied sufficiently. Main determinants include no streaking, even coating and little to no dripping.

The hydraulics attached to each arm will need to be adjusted as to make sure that the right amount of pressure is applied. Too much and there is a risk of damaging the metal, too little and the coating applied will not be even. It is also important to ensure there is enough movement available that the applicator can meet safety standards.

Applicator durability will be tested by soaking the sponge in the oil solution and conducting an abrasion test. Dr. Easter will be consulted for further guidance on best testing methods. The standards for the applicator are that it needs to meet a two-week life span.