Quick Change Electrical Connection

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Engineering Analysis

Document

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1.0 Introduction

This project works with Raytheon, a defense company, to design a self-aligning quick-change electrical connector. Our job is to create a design that self-aligns the electrical connector and provides a secure contact of that connection when the nose and body of the missile are connected. Our design must operate under the normal weapon operating conditions successfully.

This report analyzes the given criteria and how the prescribed conditions will effect material selection. This report will also describe the concepts that are being analyzed. It will then discuss the various parameters used in the concept selection and what is to be expected for our next steps as we move toward choosing our final design.

2.0 Problem Statement

<u>Goal:</u>

Design an improved electrical connection alignment using the constraints given by Raytheon. The constraints and how they affect the design choice will be further analyzed later in the report.

<u>Constraints:</u>

- Must fit in a limited space.
- Connection must be maintained for a small mating tolerance.
- Resistance to captive carriage vibration standards.
- **Transportation Loads**: Must resist large amount of shock in all directions.
- **Temperature Range**: Must be able to handle extreme temperature differences.
- **Sand**: The connector shall be able to operate after exposure to blowing sand.
- **Dust**: The connector should be able to be exposed to dust of a particular concentration.

- **Water and Ice**: The nose assembly should be able to be operated under exposure to water and ice concentrations.
- **Bomb Rack Ejection Shock**: Must be able to resist large loads due to acceleration from ejection of an aircraft.
- **Corrosion Resistance**: Must be able to resist exposure to salt solution.
- Must be compatible with the currently used jet fuel.

3.0 Concept Selection

In this section we will discuss the three designs that will be analyzed in the later sections. This gives an overview of what is to be expected from our designs and their special features. Our top pick for our concept selection is our solid guided design. This design allows for both self-alignment of the connection and a secure mating of the two halves of the electrical connection.

The biggest part of this design, shown in figure 1, is the self-aligning slant that the connection has, which would allow the chosen port connection to slide into the other half of the connection effectively and automatically. This meets the requirement by Raytheon to have a self-aligning electrical connection that will mate when the nose and body of the missile come together. No matter how far off the aligning of the nose to the body of the unit is, the connection is sure to always align and connect. Additionally, with a gasket or similar material around the outer edge of the connector, as the two parts are mated, the gasket is pushed against the opposing face, making a tight seal immediately next to the connector to avoid contamination by moisture or dust.

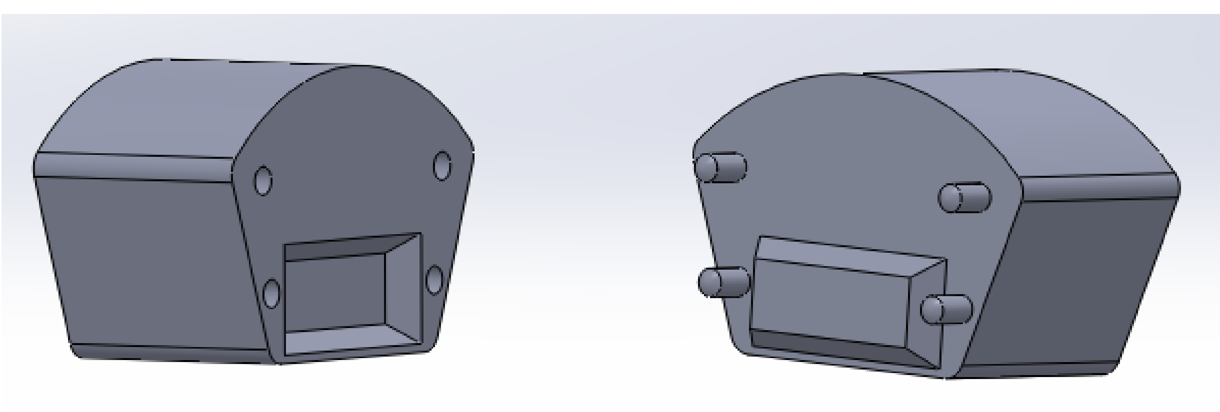

Figure 1: Solid Guided Connection

This design is optimum for securing alignment in all coordinate directions. However, it does not guide the electrical connector in place and therefore the nose and body alignment must be perfect. The four bars will be connected to the keep in zone by screws or adhesive, and will be connected to the electrical connector by some form of adhesive as well. It will also prevent any movement due to forces in any direction. This design however, does not do a great job of shielding the wires from any debris that could potential harm the system.

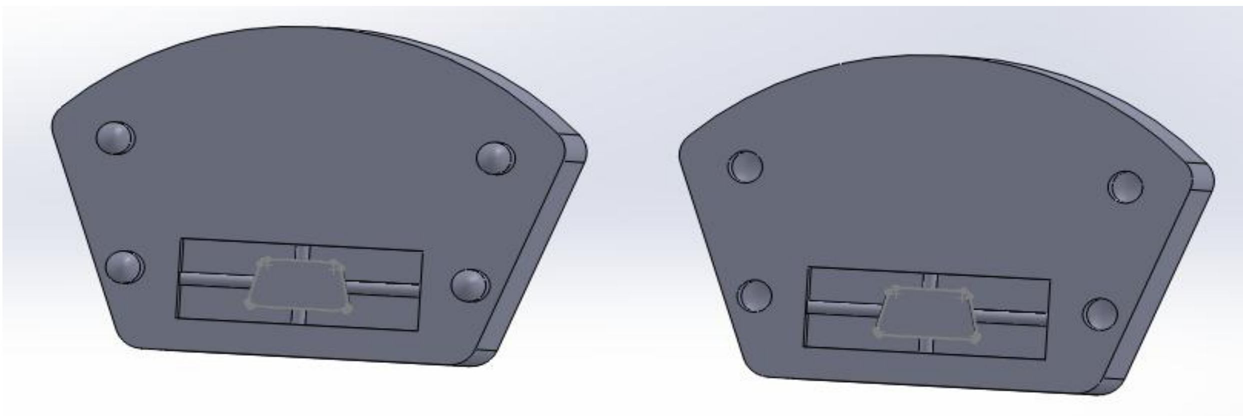

Figure 2: Stabilizing Bars

The third choice for the design is the flexible material. The flexible material is symbolized by the black rectangle in the design below in figure 3. The purpose of the flexible material is to allow the connection to happen without damage to the missile head or body. Also in the presence of any misalignment the connector will be gently moved into place by the rubber -like material. The connection is the grey trapezoid inside the black rectangle.

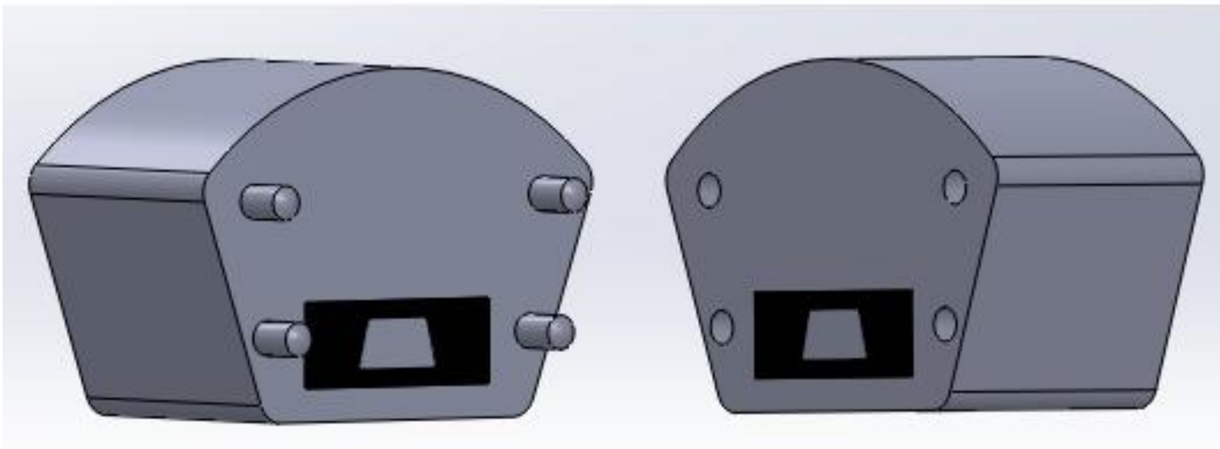

Figure 3: Flexible Material

4.0 Engineering Analysis

The focus for evaluating the materials used in our concepts will be the specified operating conditions that were previously discussed. These are the most important because if the developed design cannot meet all of the given criteria, then it will be considered to have failed. Based upon the different conditions that that design must operate under, the team has comprised a list of material properties that will allow for the final design to withstand these conditions. This list of properties includes have a low thermal conductivity, be corrosion/rust resistant, high ductility, high hardness, and also a high tensile strength. Though for many of these properties there is often a decrease in one when another property becomes higher. Due to this the team is trying to find the best balance in these properties so that the final design can be constructed, and materials chosen, as best as possible. For the previously mentioned design the team decided on a property that is considered highly, if not most, important for that design.

For the solid guided connection it was decided that the materials modulus of elasticity is the most important. This was decided because the team feels that a strong ductile material would fit the needs and goals of this design the best. Two materials being considered that have higher values are carbon and stainless steels, with modulus of elasticity values of 30.0 Mpsi and 27.6

Mpsi respectively. Another material that is being considered is aluminum. Though it has a modulus of elasticity value of only 10.4 Mpsi. This material is still being considered due to its other properties, such as weight, that the team still highly values.

The power loads in which our design will be operating under are the most important criteria for the stabilizing rods design discussed above. This is because the design must be able to handle the forces that will act on the rods. If the design cannot resist these loads then it will render the design useless in holding the connection in place. To be sure that the design and material selected will be able to withstand these power loads, the team will calculate the axial and normal bending stresses with consideration to temperature effects. From these calculations the team will be able to determine if the design is acceptable for these power loads.

A most important criterion has yet to be chosen for the flexible material design. This is because of the lack of experience within the team in working with these types of materials. Materials being considered and researched are things such as those with rubber and silicon bases. While these materials will be able to meet many of the constraints that have been put in place, but there are a few constraints that it is unknown to the team if there are any flexible material options that will be suitable. Even with these concerns the team wants to keep this design as a viable option because it could be possible to integrate this concept with on of the other two designs that are still under consideration.

Our team is still in the process of analyzing all three of our designs, as none of them have been determined unacceptable. The designs will continuously be evaluated, the overall design as well as the material options, based upon whether or not they are able to meet the given constraints. This is an on going process that will lead our team to choose the design that will best complete our task.

5.0 Gantt Chart

As shown in Figure 4, our schedule is following closely to our original plan. However, we found that due to the nature of our project with Raytheon, we needed to extend our analysis of the forces on the system as well as our considerations of the environmental conditions through to the end of the month. This is due to the fact that we have many environmental factors to account for and analyze accordingly – including the forces on the system when it is ejected and weather-related factors such as sand, water, salt, and dust.

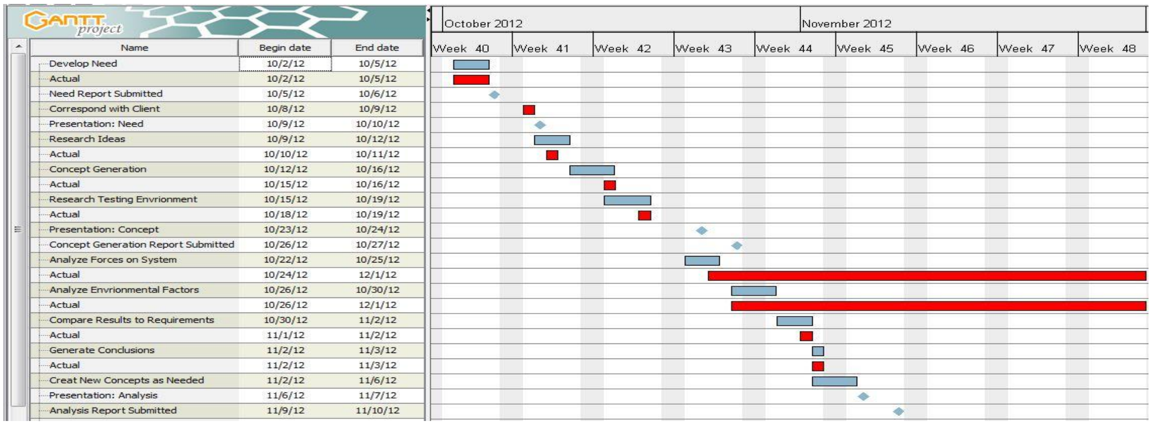

Figure 4: Scheduled Timeframe and Actual Time Taken

Our future plans, outside of the continual analysis of the system, include acquiring data from test results, as shown in Figure 5. The results at this time would be based solely on theoretical models of the system using CAD software and overall analysis as a team. Additionally, the use of Mechanics of Materials and Machine Design equations will help in analyzing and testing the designs, giving us a final design concept for next semester.

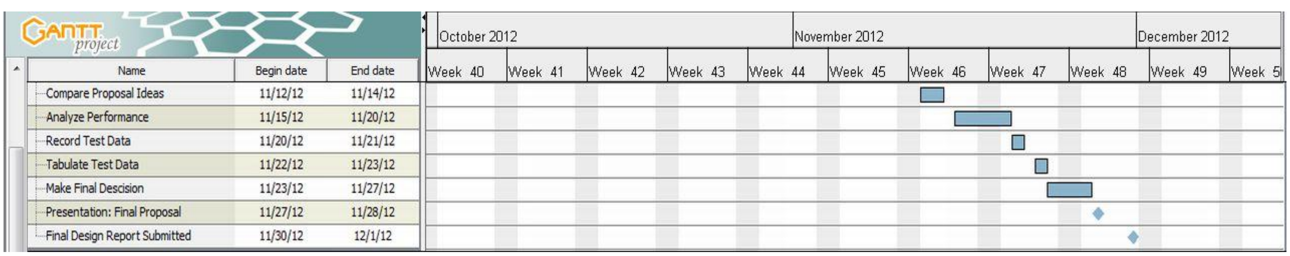

Figure 5: Schedule for the rest of the semester.

6.0 Conclusion

In conclusion, this document covered the problem statement for this project with Raytheon missile systems and their need for a new electrical connection setup. From there, three final candidates out of the original 6 unique designs were chosen as a possible final design, with subsequent decisions based off of these designs. Additionally, a basic analysis of these three designs was done to determine which designs might be better than others based off of our requirements. This includes a look at the material used to construct the given setup and how well it meets the requirements laid out by Raytheon. Finally, the updated Gantt charts give a look at how well the team is staying on schedule, as well as addresses any issues that have changed the schedule. Overall, the team is progressing along at a steady pace and will come up with a final design for the project soon.