Release Lanyard Design

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Team 05

Concept Generation and Selection

Document

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Introduction

Raytheon Missile Division located in Tucson, Arizona is a well-known company that specializes in defense electronics. They have discovered that their current lanyard system design is highly susceptible to extreme temperature changes and contaminates. These environmental conditions have triggered multiple failures. As a result, Raytheon has presented our team with this engineering problem.

Problem Statement and Goal

The current lanyard design does not address issues relating to extreme temperatures and environmental effects, which leads to system malfunction. Our goal is to design a low cost release lanyard that can withstand extreme temperatures and environmental effects.

Concept Generation

According to the requirements provided by our sponsor, there are certain components of the current design that cannot be altered. This pertains to the lanyard attachment point on the aircraft, ground safety pin preventing early activation, and the location of the battery and switch. With this in mind, our team identified the potential areas of redesign. The categories of redesign pertain to the:

1. Cable Options

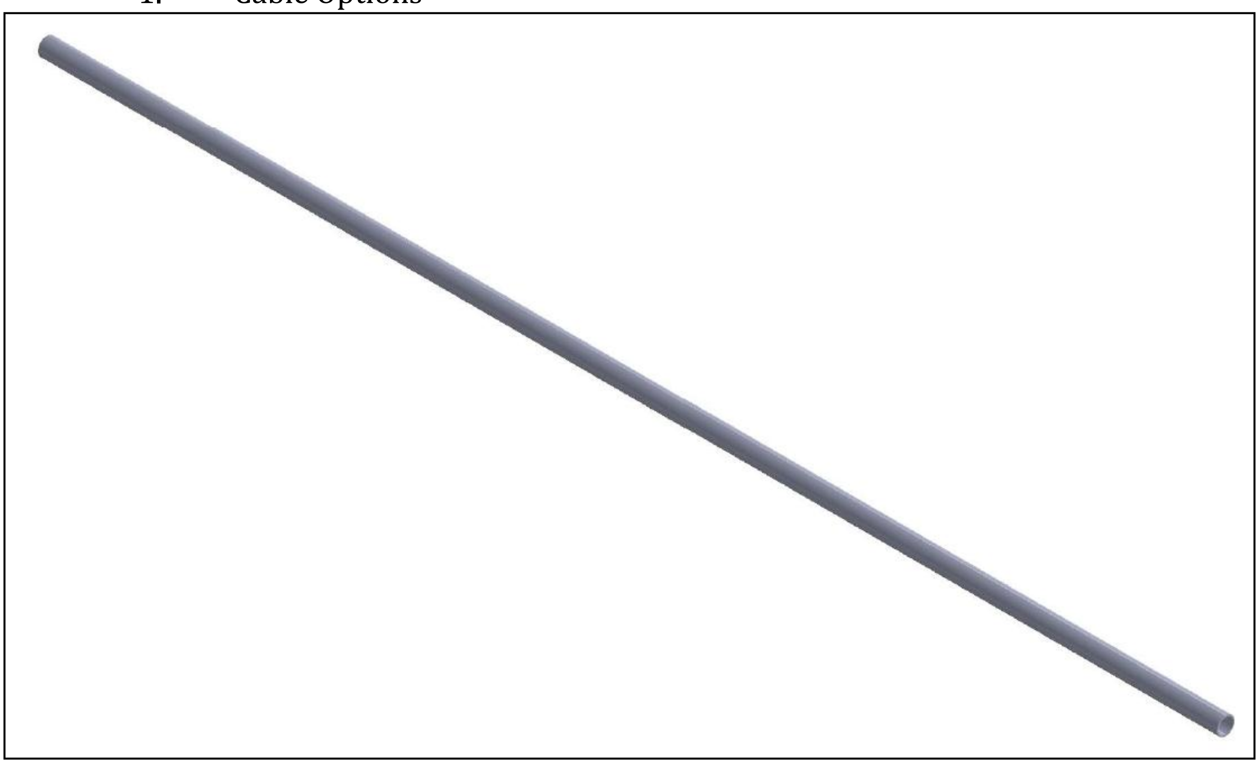

Figure 1: Current guide pipe

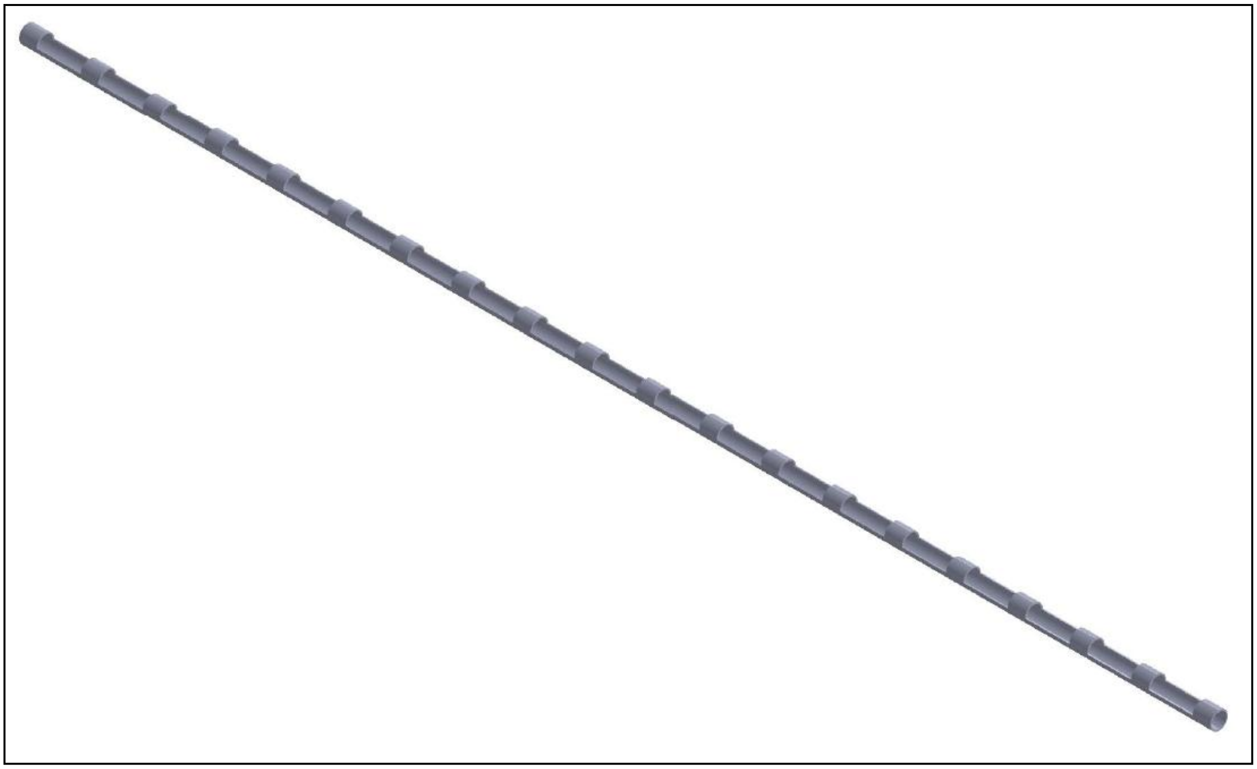

Figure 2: Slotted guide pipe

2. Cable Guide Components
3. Activation System

A few desired features that needed to be considered in this concept generation process include:

1. Easy to Correctly Assemble and Install External Cable, Guides, and Activation System while in the Field
2. Cost Less than the Current Design

With the design criteria identified, we began the concept generation process and produced the following designs. Our cable option designs included cable coating or eliminating the cable and switching to a rigid rod or electrical system. The cable coating would be a Teflon/Tyvek tubing material. This feature would protect the cable from fraying and being damaged by the potentially sharp edges of the guide pipe.

There were two design ideas that could potentially eliminate the cable. The first idea was to replace the cable with a rigid rod. This would ideally eliminate the failure due to the cable "locking-up" within the guide pipe. However, after further discussion we realized that this design had the potential of compromising the integrity of the vehicle or the device it was attached to. The second idea reduced the length between the activation pin and the cable attachment point to the vehicle. When considering the force transferred from one location to the other to activate the switch, the electrical wire design incorporates a different thought process of moving the mechanical force needed to activate the mechanism much closer to the clip-in point pin and thus greatly reducing the distance of transferred force. This would be accomplished by almost completely removing the cable wire and replacing the battery slider assembly to an electrically based system by breaking/opening the loop via the two pull pins which will close/open the electrical loop and arm the mechanism as it would normally.

Our cable guide component designs included a cap over the guide pipe opening, lubrication, creating radius edges, creating a funnel opening, a rubber guide within the pipe, and reducing the guide pipe to an array of steel rings. The cap would be manufactured from a durable plastic or rubber to prevent water and contaminants from entering the guide pipe system. This would be applied to the current guide design and could be paired with the lubrication idea. There are several lubricating products that work at extreme temperatures and could fill the inside of the pipe system to prevent compromise. Creating radius edges on the ends of the guide pipes would eliminate the sharp turns of the current guide pipe system. The funnel opening feature would remove the sharp edges that are leading to the cable fraying, but has the potential of increasing contaminant buildup at the opening. The last two design features are paired together. The rubber guide would lie at the bottom of the array of steel rings. This allows the cable to glide smoothly when a force is applied to one end. The final guide alteration consists of an array of steel rings and can be seen in Appendix A. These steel rings may be circular or even horseshoe in shape.

This last group of designs pertains to the actual activation system. The 3D sketch below depicts what the current design might look like. The first design considered simply extends the activation arm and repositions the connection point of the cable to create a greater torque. The second design utilizes a spring and a pull pin. Once the safety pin is removed, the operation is ready to be carried out. As soon as the force is transmitted to the holding pin, the pin would be removed from its resting position and a spring would in turn force the activation pin out of the crevice. The final design pertaining to the activation system converts the pivot assembly to a slider switch. A depiction of this assembly can be found in the Appendix. The principles of this design are the same as the current design. When the cable experiences a force, it is translated to the activation assembly, but rather than causing a pivot action the system slides. Each of the concepts produced address the environmental conditions experienced while the weapon is attached to the aircraft (vibration, sand and dust, icing, etc.).

Concept Selection

Based on the criteria provided to us by our client, the following decision matrices were constructed. As mentioned before, our team identified three primary areas of redesign. The scale used for the matrix values can be found below. It is constructed with 5 being comparable to the current design and 1 one would be much worse.

Based on the decision matrix found below, the switch slider assembly appears to be the best design option for the activation system. The switch slider can be found in Appendix A.

Table 1: Activation Arm

Scale	
1	Terrible
2	
3	
4	
5	Moderate
6	
7	
8	
9	
10	Excellent

Activation Arms				
Criteria	Weight	Switch Slider	Extended Arm	Spring Loaded Arm
Cost	0.1	2	3	2
Contamination	0.4	6	5	3
Temperature Range	0.2	5	5	4
Installation Time	0.1	5	5	4
Ease of Installation	0.1	4	5	3
Dimensions	0.1	8	3	7
Weighted Sum	1	5.3	4.6	3.6

Once the cable options were sifted through, we were able to construct the decision matrix below. According to the weighted values, cable coating appears to be the best feature for this design category.

Table 2: Cable Options

Cable Options				
Criteria	Weight	Cable Coating	Electrical Wires	Rigid Rod
Cost	0.1	3	2	4
Contamination	0.4	8	6	6
Temperature Range	0.2	5	5	5
Installation Time	0.1	3	4	6
Ease of Installation	0.1	4	4	6
Dimensions	0.1	5	8	2
Weighted Sum	1	5.7	5.2	5.2

With two of the three areas of design addressed, the final decision matrix provides an analysis for the cable guide component designs. After performing the appropriate calculations, it can be seen that the cap feature would address the necessary criterion. A 3D sketch of the design can be found in Appendix A.

Table 3: Cable Guide Components

Cable Guide Components					
Criteria	Weight	Array	Radius Edges	Cap	Lubrication
Cost	0.1	4	4	3	3
Contamination	0.4	7	5	8	4
Temperature Range	0.2	5	5	5	7
Installation Time	0.1	4	5	5	3
Ease of Installation	0.1	4	5	5	3
Dimensions	0.1	5	5	5	5
Weighted Sum	1	5.5	4.9	6	4.4

Once our team had the results of our decision matrices, we combined the design concepts to configure a possible final design. According to the results, this final design would utilize a Teflon/Tyvek the current cable containing the fusible link. This cable would weave through the current guide pipe system, but include a cap to prevent contaminants from entering the piping. One end of the cable would be attached to the vehicle and the other end would be attached to the switch slider assembly. A 3D sketch of each piece of this potential final design can be found in the Appendix.

Project Plan Gantt Chart

The Gantt Chart below in Figure 3 provides the framework for the completion of this project. The chart will also aid in allocating our project resources and provide milestones to evaluate our overall progress. The segments in grey represent the proposed time frame for completing each task. Our planned/designated time line for each task is represented by the segments in green. The time it actually took to complete each task is represented by the segments highlighted with yellow. Our current position as of today October 24, 2012 is represented by the dashed line dividing the Gantt Chart.

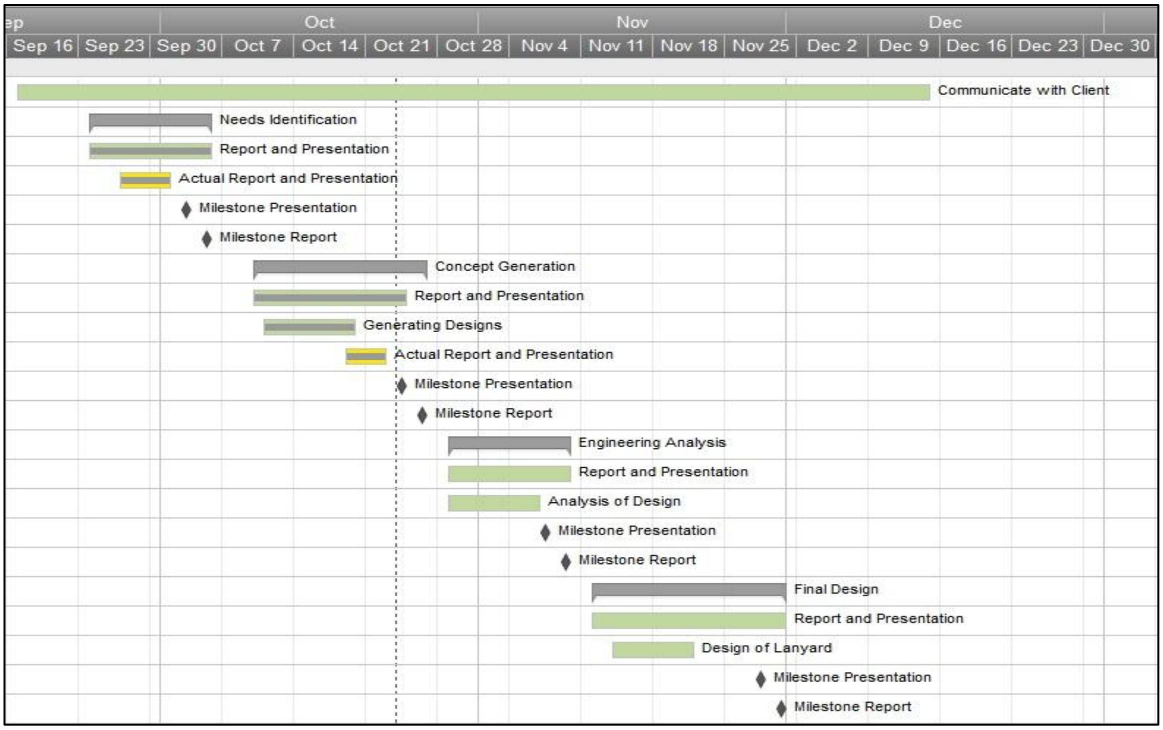

Figure 3: Gantt Chart

Conclusion

After reviewing the criteria that our customer provided to us, we began our concept generation by determining categories of the release lanyard to be redesigned. We decided on three main categories for redesign including cable options, cable guide components, and the activation arm. We then began the brainstorming process to generate design concepts. We constructed three separate design matrices to decide upon our top ideas. After carrying out the necessary calculations, the most appropriate final design would utilize a Teflon/Tyvek the current cable containing the fusible link. This cable would weave through the current guide pipe system, but include a cap to prevent contaminants from entering the piping. One end of the cable would be attached to the vehicle and the other end would be attached to the switch slider assembly. As of right now, the team is waiting to speak with the client to decide what design they would like us to proceed with. Once we obtain confirmation and direction from the client, we will be able to perform additional analysis on the design and proceed to meet our upcoming goals.

Appendix A

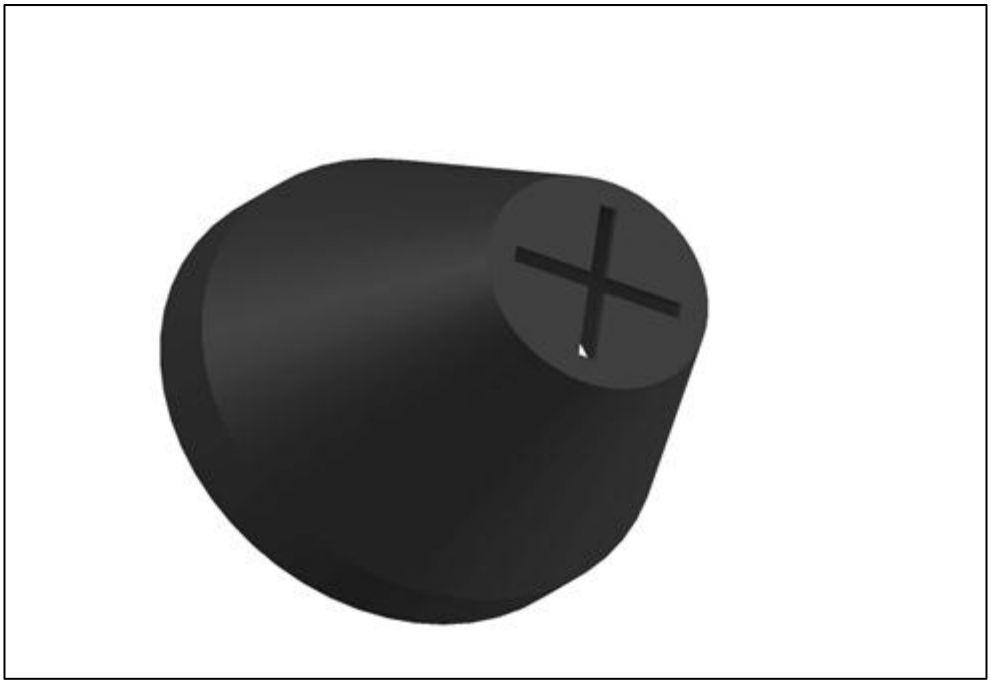

Figure 3 - Cap for Guide Pipe

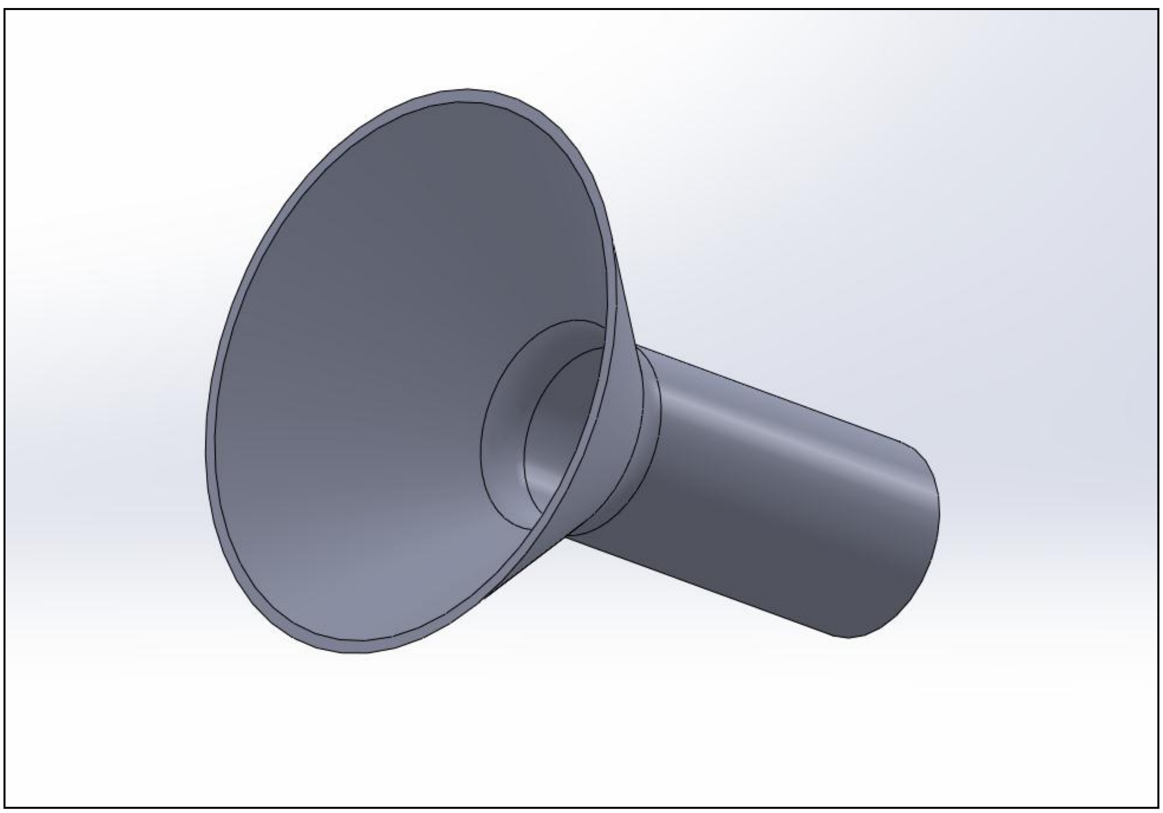

Figure 4 - Funnel Opening for Guide Pipe

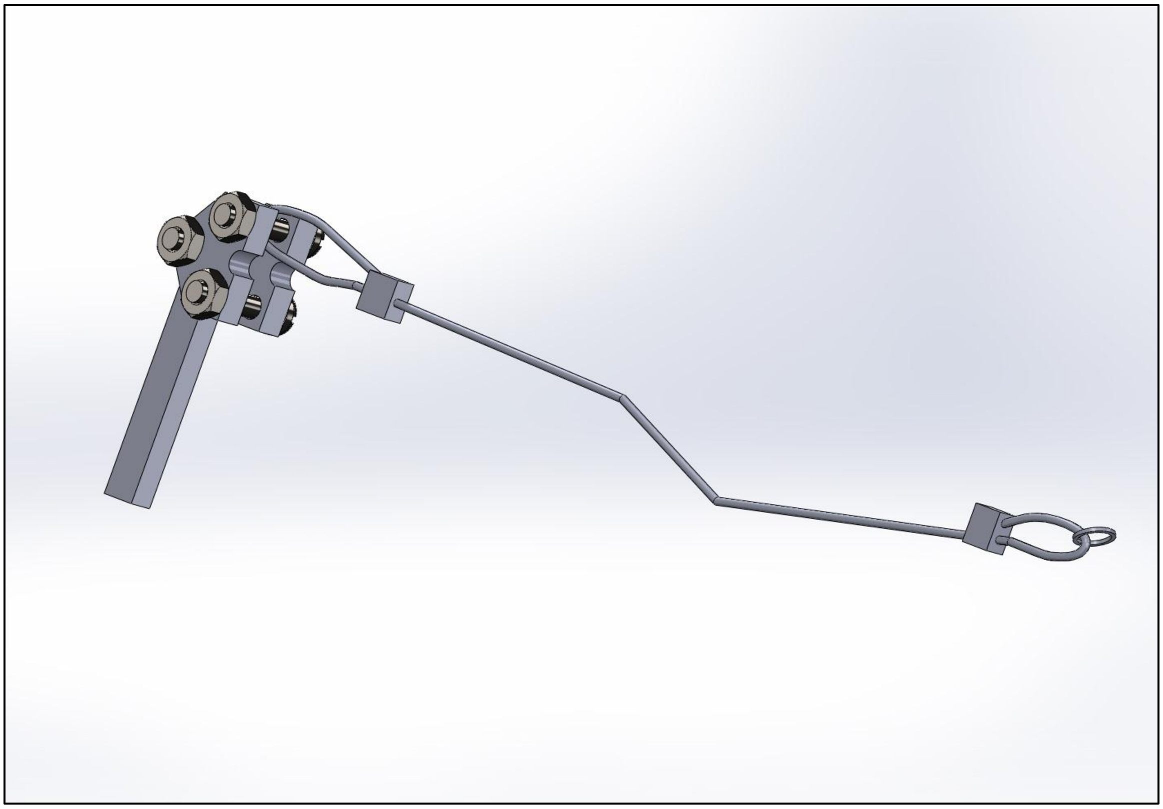

Figure 5 - Current Design

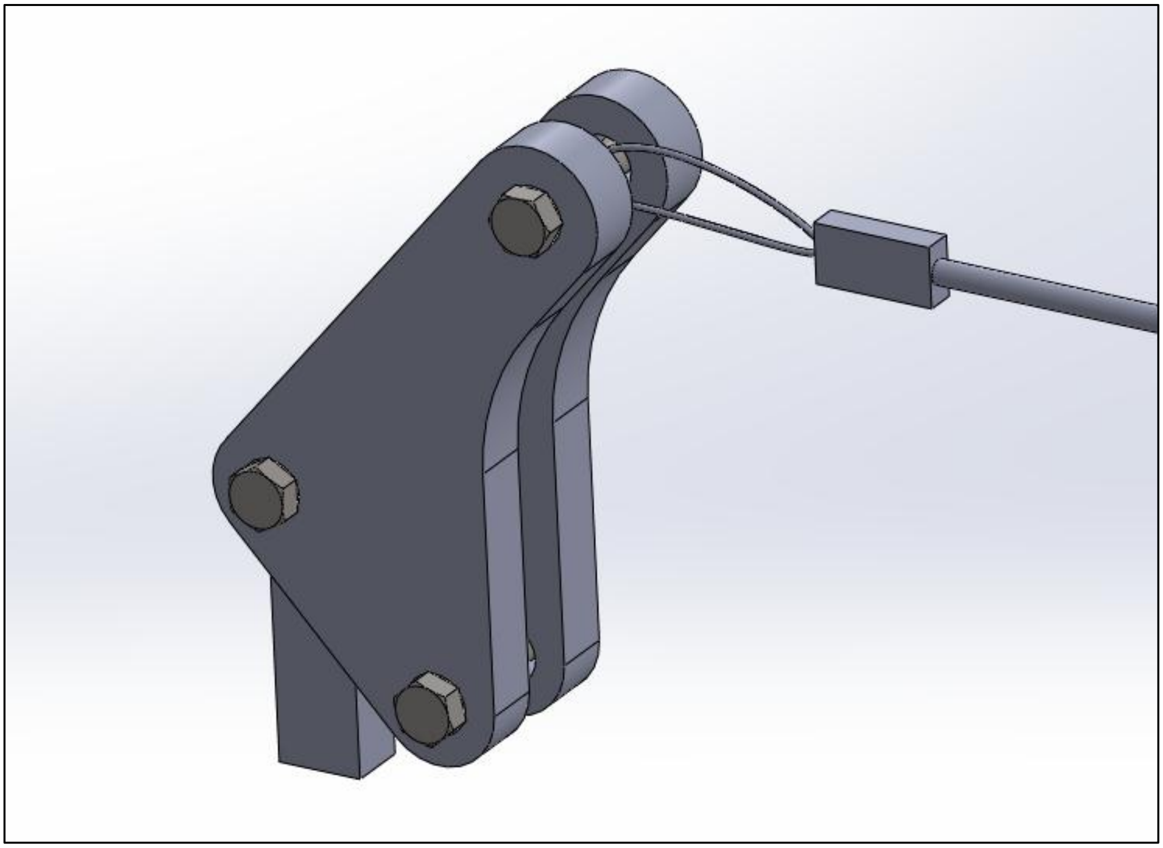

Figure 6 - Extended Arm

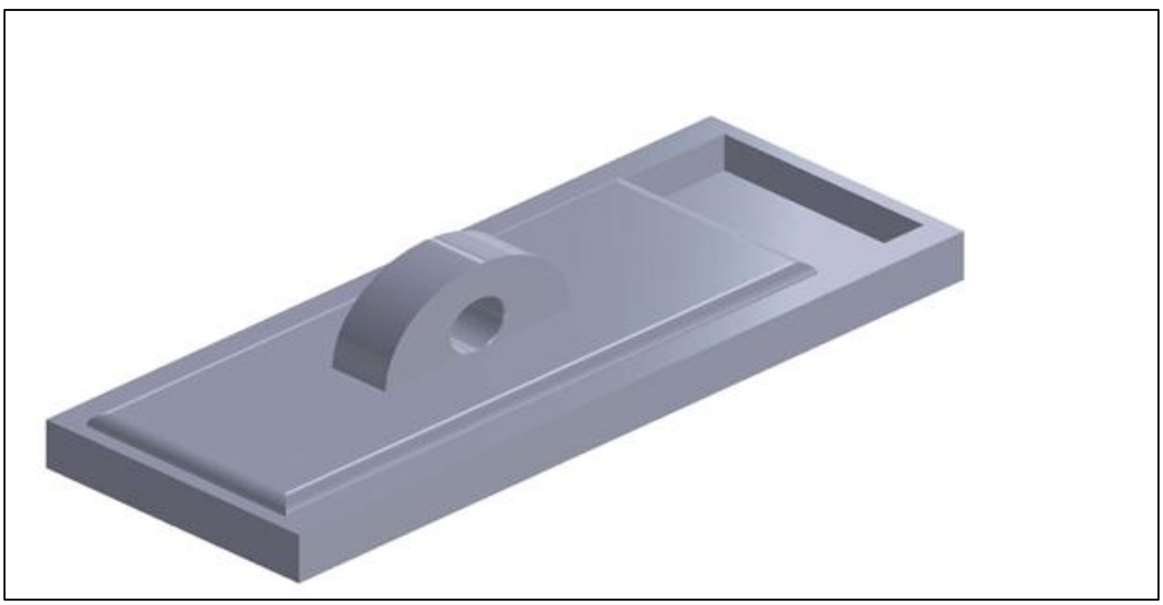

Figure 7 - Switch Slider Assembly