Technical Memorandum  
No. EDSGN100.002

Date: April 25, 2016

To: Lockheed Martin Corporation

From: EDSGN100 Section 002  
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Subject: Penn State University  
EDSGN 100: Introduction to Engineering Design  
Client-Driven Design Project, Spring 2016

Purpose. Leverage additive manufacturing technology to solve new problems or redesign existing solutions. Use additive manufacturing’s ability to create geometries that were previously impossible to reduce weight, cost, and assembly time. Improve designs iteratively through rapid prototyping made possible with desktop additive machinery (i.e. MakerBot).

Background. Additive Manufacturing, or industrial 3D Printing, is the process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies like drilling, milling, grinding, or turning.

In the aerospace industry, the most critical aspect of almost any design is weight. Every pound of weight you can remove from a satellite or aircraft structure can be replaced with a pound of extra payload (bigger antennas, larger sensors, more batteries, etc.) or fuel (increased range).

Conventional (subtractive) manufacturing methods start with more material than is necessary and then remove material to get to a finished shape. Sometimes, it is not possible to remove all of the material you would like due to limitations of geometry and subtractive methods. With additive manufacturing, you only add material where you want it so the resulting structures can be significantly lighter than their subtractively-manufactured counterparts.

At Lockheed Martin, our engineers and designers are using additive manufacturing in a variety of ways. It is used for conceptual design to do rapid iterations of design ideas before committing to more expensive materials like aluminum and titanium. Additive manufacturing is also used to fabricate manufacturing fixtures and tooling (drill fixtures, alignment templates, custom hand tools, etc.) very quickly and at significantly lower costs than traditional tools. Finally, it is being used to dramatically reduce weight on the
products we deliver to our customers and create new parts and structures that were never before possible.

**Sponsor.** Headquartered in Bethesda, Maryland, Lockheed Martin is a global security and aerospace company that—with the addition of Sikorsky—employs approximately 126,000 people worldwide and is principally engaged in the research, design, development, manufacture, integration and sustainment of advanced technology systems, products and services.

**Project Description.** The purpose of this project is to redesign a USB Hub Mounting Bracket used as a debug and auxiliary mounting device for a custom avionics mission system. The new USB Hubs will provide greater capability for the avionics technician through an increased capacity of connections and allow for installation in various areas on the platform. The primary goal of this project is to reduce the total number of parts for this assembly and provide a vertical installation configuration. Your work will involve the following:

1. Design a bracket for a 7-port USB Hub
2. Design a bracket for vertical mounting
3. Design new cable retention for USB and Power cables
4. Bonus: Design a bracket for stacking three Hubs together
5. Bonus: Design a bracket for mounting horizontally

This project was chosen because the design team was most familiar with the design of the USB hub and the team felt that their skills would be most applicable to this particular project.

**Procedures.** First, the design team examined the example USB hub case to look for weaknesses in the design. It was found that the original design had several unnecessary parts that could be removed and some material could be removed to lower the cost. Then, possible improvements were discussed and several sketches were made to plan out potential options. Next, a design was chosen based on feasibility, adherence to the design criteria, and effectiveness. The new design improved upon the number of parts needed to complete the assembly, total amount of material used, and allowed for several cases to be securely stacked together. Next, the measurements for the USB hub were researched and the design for the new USB hub case was dimensioned accordingly. Following this, a three dimensional model was created using Solidworks. Finally, a prototype was made using 3-D printing technology.

**Results and Discussion.**

**Alternative Design:**

As seen in figures 3, 4, t, and 6, the revised design of the hub bracket is made from 3 separate parts, the main body, the front plate, and the back plate. The main body, shown in figure 4, is dimensioned so that it can hold two 7-port USB hubs stacked vertically. It has two projections coming off of the top and bottom surfaces to allow the bracket to be screwed into the base and attached to other brackets. There are also two slots in the front and back surfaces
that allow the body to be attached to the front and back plates. The front plate, shown in figure 5, is the same width as the main body and includes 7 slots through which the cords for each of the USBs will be threaded. It also has two protrusions coming from the back face that will slide into the slots in the front face of the main body. The back plate, shown in figure 6, is wide enough to cover the power cable ports but not the entire width of the USB hub. It includes two holes for the cords to go through and two protrusions on the back face that will be put through the slots on the back of the main body to connect them.

**Evaluation:**

There were many things about that original design that had to be improved upon. These included increasing the bracket’s capacity, reducing material usage, and allowing for vertical stacking capability. The new design accounted for all of these things in several ways. First, the bracket’s capacity was increased by increasing the height as seen in figure 4. The new height is the same dimension as two USB ports placed on top of each other. This will allow them to remain firmly in place. To reduce material usage, first the total number of screws was reduced. The front and back plate snap into place instead of screwing into place. In addition, the back plate does not cover the entire USB port, it only covers enough to hold it in place, which can be seen in figure 6. The edges of the bracket were filleted to reduce material usage as well. Finally, to allow for vertical stacking capability, the bracket has protrusions on the side of the top and bottom (figure 3). These protrusions have screw holes, thus allowing a connection when one bracket is placed upon another.

**Conclusions and Recommendations.** The new design is more effective in a way that it uses fewer materials and there are fewer parts that need to be joined together with screws. It allows several USB brackets to attach to one another and better utilizes space in the workplace. Also, the modified “teeth” part of the bracket allows easy access to the USB ports as well as it allows the USB to be kept into place after installation. The new design meets all the design criteria and has further improved the original model. It would be an honor to further be a part of this project and on other engineering practices that Lockheed Martin facilitates. Thank you for this opportunity to work and improve on your products. If there are further questions, do not hesitate to contact at: email, mfk5208@psu.edu.


**Attachments.** Table 1 and Figures 1, 2, 3, 4, 5, and 6 are attached.

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TABLE 1
LENGTH CONVERSION FACTORS

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Figure 1. Conceptual design of hub mounting bracket provided by Lockheed Martin, front view
Figure 2. Conceptual design provided by Lockheed Martin, back view
Figure 3. Final design fully assembled
Figure 4. Final design of main body piece
Figure 5. Final design of front plate
Figure 6. Final design of back plate