Orbital Test Stand

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Midpoint Review
Document

Submitted toward partial fulfilment of the requirements for
Mechanical Engineering Design II – Spring 2015

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1.0 ABSTRACT

Orbital ATK is a manufacturer of small and medium class launch vehicles for carrying payloads into Earth orbit for NASA and other companies. In Chandler, AZ where the Launch Vehicle Design and Manufacturing branch is located, tests are conducted on the payload fairing to ensure this component will tolerate the dynamic loads experienced during launch. Loading simulation is conducted on the company's test stand in a horizontal rather than a vertical position. This requires the two halves of the clamshell fairing to be mounted one at a time, rotating the test stand to a stable position once each half is loaded. Mounting of the two pieces is a time-consuming and delicate process due to the use of an overhead crane which doubles as a brake to prevent the mounting ring from freely rotating. This system puts the technicians and engineers around at risk in the event the crane fails. Orbital ATK has asked our capstone team to design, build, and integrate a system to automate the test stand reducing set-up time and increasing the safety of its employees. The design chosen takes the form of two wheels driven by electric motors mounted to the interior of the test stand. These wheels work in tandem to rotate the test ring at no more than 1 rpm in unloaded, partially loaded, and fully loaded regimes. After a few meetings with management and other staff, Orbital ATK has approved the concept and are working with our team to integrate the design.

2.0 MANUFACTURING

2.1 CNC Machining

Due to the size of the primary adapter plate the holes must be machined on a CNC mill. The engineering machine shop has a Haas with a large enough jaw to facilitate the larger plate. The G-code to control the tool path has been developed and will be implemented by the end of March.

2.2 Tension Update

The tensioning device will be constructed from an aluminum bar and a lead screw. Research was conducted on the availability of a lead-screw tensioning device and it was determined that manufacturing one would be an easier and cheaper alternative.

2.3 Manual Mill

The 1 inch thick Aluminum 6061 plates that were obtained from IMS were not the correct dimensions required to make the plates that we needed. Our team met in the machine shop to cut the plates down to the correct size and begin drilling the slots and the holes in the Slotted Vertical Plate.

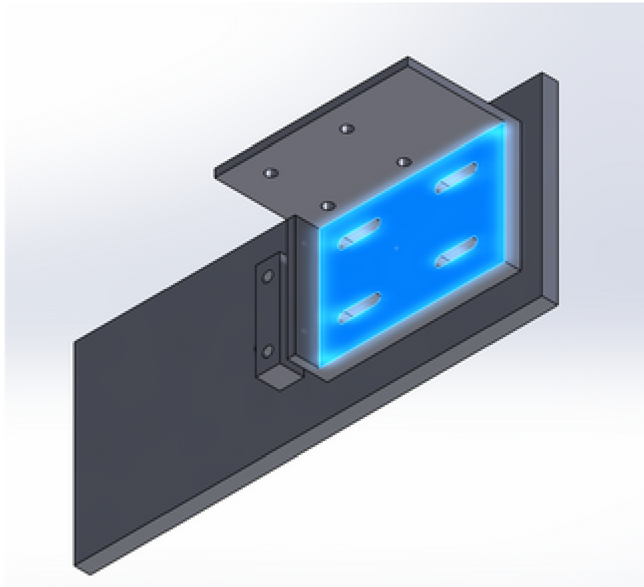

Figure 1: Slotted Vertical Plate Highlighted in Blue.

The vertical bandsaw was used to cut the aluminum plates down to their correct sizes of two (2) 7x13x1 plates and two (2) 8x13x1 plates. The plates had their square edges aligned and tested and the alignment looked good, so the process of drilling the slots into the 7x13x1 plates began.

The slots were cut using a milling tool, using 4 consecutive ¼ inch depth passes to create the full 1 inch deep slots. This process was repeated for all 4 slots per plate, and finally for both of the plates. One of the post-slotted plates can be seen below in Figure XX.

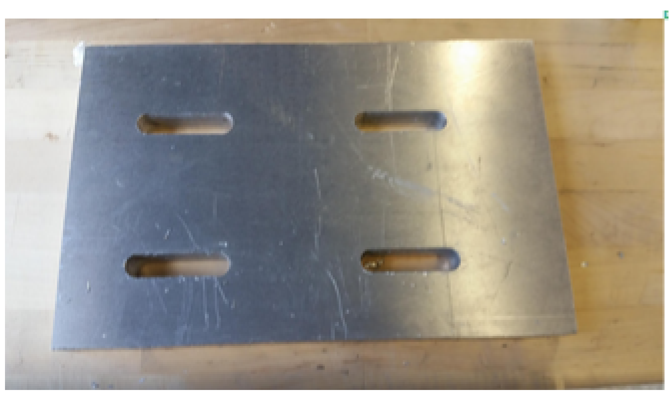

Figure 2: Slotted Vertical Plate.

2.4 Present Work

Now that the plates have been cut to the correct size and also now have the slots in them, the holes must be drilled to allow for the threaded inserts to be placed within and actually begin bolting the structure together. The threaded inserts will be placed into the plates to provide additional strength since the steel bolts would cross thread the aluminum and also would shear through the soft material. The full assembly of the plates can be seen below in Figure 3.

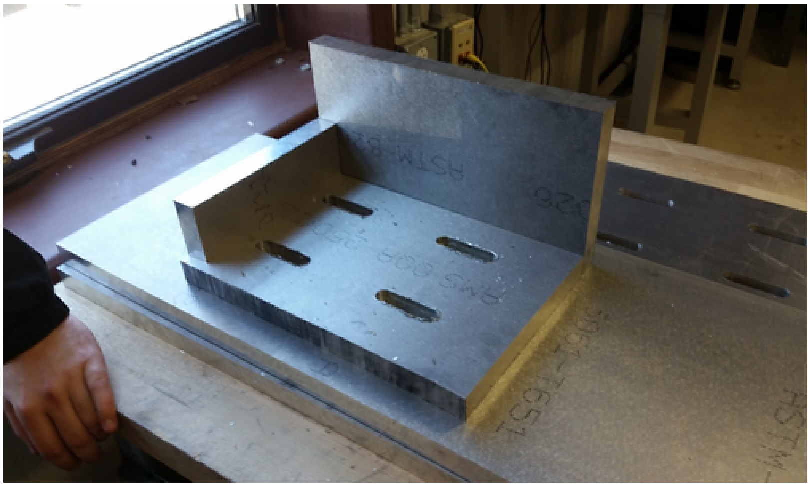

Figure 3: Assembly Layout.

The Slotted Vertical Plate will have threaded inserts along the top and the right faces to allow it to be bolted to the 8x13x1 inch Horizontal Plate as well as the triangular supports on the side (not shown). The Vertical Slotted Plate will have 6 inserts going across the 13 inch width and then 3 inserts going down the right face to allow for the triangular support to be bolted. The Horizontal Plate will have 3 holes along its right face also, so the triangular support will connect through those 3 holes in the right faces of both plates. An isolated view of the threaded insert hole locations on the Slotted Vertical Plate can be seen in Figure 4.

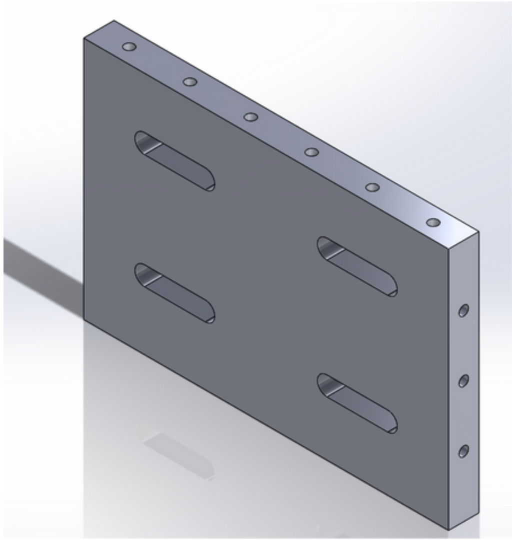

Figure 4: Threaded Insert Locations for Slotted Vertical Plate (Solidworks Isometric Shot).

Once the holes for the threaded inserts have been made, the inserts can be used and the entire assembly can be bolted together.

3.0 WHEEL ASSEMBLY

The tire will be attached to a spindle which will allow it to rotate freely. A sprocket will be attached to the tire's wheel hub which will allow the chain to rotate the tire as desired. The sprocket will have four holes drilled into it. Bolts will be placed through these holes, a spacer, and the four holes on the tire hub. The bolts will keep the sprocket attached to the tire.

4.0 MATERIAL ACQUISITION

To reduce the weight of our assembly our team choose to use Aluminum plates, specifically Al6061. This type of aluminum would be light weight and strong enough for our application. We contacted Roger Cundick from Industrial Metal Supply (IMS) in Phoenix, AZ. The following items were donated by IMS: 1inch thick 6061 plates for (2) 12x30 in, (2) 13x17 in, and (2) 2.5x8 in.

Additional items that will be ordered during Spring Break week will be the threaded inserts from McMaster, the spindle from Pacific Trailers and the pneumatic tire from McMaster.

4.1 Motor and Gearbox

The selected Motor from McMaster and the Speed Reducer from Grainger are being ordered by Orbital themselves and will be delivered to our team after inspection by Orbital. Once the motor and speed reducer arrive we can continue with full assembly and attach to the horizontal plates for testing.

5.0 THREADED INSERTS

Throughout the description of the plate assembly above, we discuss the use of threaded inserts. These inserts provide additional strength to bolt holes, prevent cross threading, and ultimately account for the issues involved with sinking a steel bolt into an aluminum plate. We have chosen to use 3/8-16 in. 360° swage blind threaded inserts for both their pull-out strength and convenience. In total, we will use 40 threaded inserts, which was not accounted for in our original budget. However, these inserts are relatively cheap; we can get 50 inserts for $29.83 at a local store in Flagstaff, Arizona. Installation of these inserts, however, requires a specialized tool ($79.99) and it will be purchased locally.

6.0 CONCLUSION

In conclusion, we have nearly completed the final assembly for the mounting system for use on the test stand. This is one of the most important phases of the entire design; as such, it is also the most time consuming. Once finalized, we estimate that we will be more than 75% done with the project. Remaining task items include mounting the motor and gear box on the horizontal plate of the mounting system, mounting the wheel and spindle on the test stand adapter plate, installing the lead screw system, and finally, preparing for final installation at Orbital ATK facilities in Chandler, Arizona.