Orbital Test Stand

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Team 7

Winter Progress Report

Document

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1.0 INTRODUCTION

The following document presents a progress report for the Orbital Test Stand project at Northern Arizona University (NAU) in Flagstaff, Arizona. Selected as the group's final design is an interior wheels concept consisting of a motor, a gearbox, two sprockets, a roller chain, a spindle, and a pneumatic tire. This document will reintroduce the interior wheels design concept already put forward by the group, as well as the progress made over winter break from school at NAU. Also included is a schedule for the spring semester.

2.0 WHEEL DESIGN

After presenting and discussing our final two design solutions to Orbital, the interior wheels concept was chosen. The interior wheels was chosen over the dual winch design due to ease of operator use, aesthetics, and space constraints. See Figure 1 for the sketch of this design. This concept takes the form of two wheels mounted to the interior of the test ring, each of which is chain driven via motor and gearbox assembly. Adapter plates will be manufactured at Northern Arizona University on which the wheels, motors, and gearboxes will be mounted. These will then be mounted to the test frame in keeping with our constraint of minimal modifications to the existing structure.

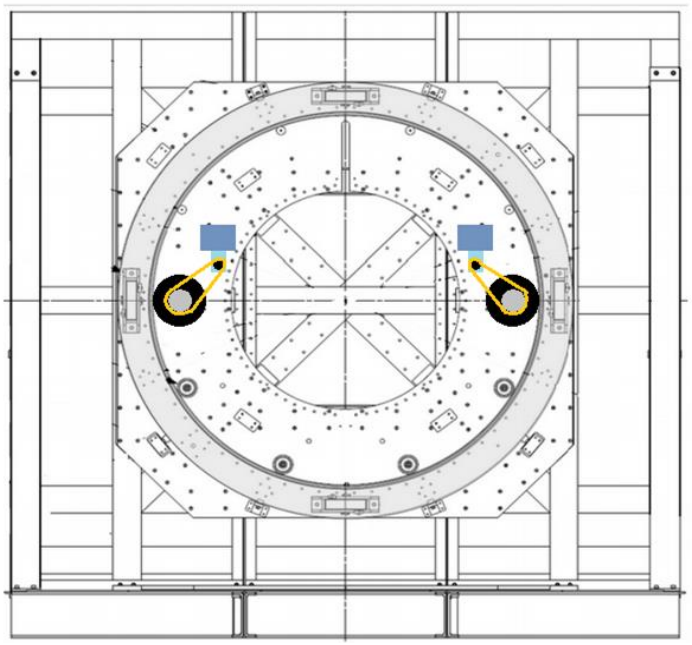

Figure 1: Interior Wheels Sketch.

2.1 Motor

Upon further research it was realized that the motor selected had too high of a horse power for the gearbox input. The motor selected produced 1 hp of output versus

the 0.88 hp input rating for the gearbox. A suitable replacement motor was found with an output of 0.75 hp with no change in cost or output RPM.

2.2 Gearbox

Gearbox configurations considered included worm drives and planetary drives. Spur gears were out of the question due to the prohibitive size to achieve the gear reduction needed of nearly 200:1. Worm drives were the next option researched, and ultimately settled on. The worm drive doubles as both a driving system for the wheel in addition to a brake as the output cannot drive the worm. This is desirable as the test ring will be unable to turn against the gearbox and motor. The worm drive chosen, however, has the ability to run clockwise and counterclockwise. A good candidate gearbox sold through Grainger reduces the motor output to 18 RPM with a torque of 1655 in-lbf.

2.3 Spindle

We chose a spindle assembly made by Gempler (Figure 2). This assembly is a four hole straight spindle stub axle which will allow the spindle to be bolted or welded directly onto the mounting plate. The spindle comes with all necessary parts and has a total load capacity of 1250 pounds.

Figure 2: Spindle Assembly.(Source: Pacifictrailers.com)

2.4 Chain Drive and Sprockets

To transmit the output rotation of the gearbox to the wheels a sprocket and chain system will be used. On the output shaft of the gearbox will be mounted a 16 tooth gear and on the wheel a 32 tooth gear. This additional stage steps the output 18 RPM to the required 9 RPM for the wheels to rotate the test stand at less than 1 RPM. The chain chosen is a single strand steel chain with a working load of 803 lbf. McMaster-Carr is the distributor for the chain and sprockets.

2.5 Wheels

Two tire treads were investigated for the final design: smooth tread and J-tread. The smooth tread was investigated for its greater contact area which in turn would yield a higher traction between the wheels and the test stand. However, the smooth tread tires only have a load rating of about 230 lbf while the J-tread tires have a load rating of

590 lbf at 60 psi. Despite the lower contact area of the J-tread tires the higher load and pressure ratings achieve the necessary contact and friction forces. The tires are 16.1 inches in diameter and 4.7 inches wide. To attain the minimum normal force to prevent the test stand from rotating when only one half of the fairing is loaded the tire center must be mounted no more than 7.95 inches from the test ring. A tire pressure of 60 psi will create a contact area of 9.5 in^2 and a normal force of 570 lbf per wheel.

Pneumatic tires are the best choice for this design because they allow the easy integration and removal of the wheel while also achieving the necessary normal forces. Since the wheels must be mounted with the centers less than one radii from the interior of the ring it is best to mount the wheels in their deflated state and then inflated to 60 psi. In the event the wheels need to be replaced they are deflated and removed. Another benefit is the option to vary the tire pressure to adjust the normal force in case there is too much or too little traction.

2.6 Mounting

To adhere to the constraint of minimal modification to the existing test stand several steel adapter plates will be manufactured in the NAU machine shop. The plates will have holes drilled in a pattern matching that of pre-existing holes on the test stand. Another hole pattern matching that of the gearbox, motor, and wheel spindle will drilled to facilitate simple integration of the assembly onto the test stand. To maintain chain tension an adjustment screw will be used to position a secondary plate which is able to slide horizontally and locked in place by tightening additional bolts.

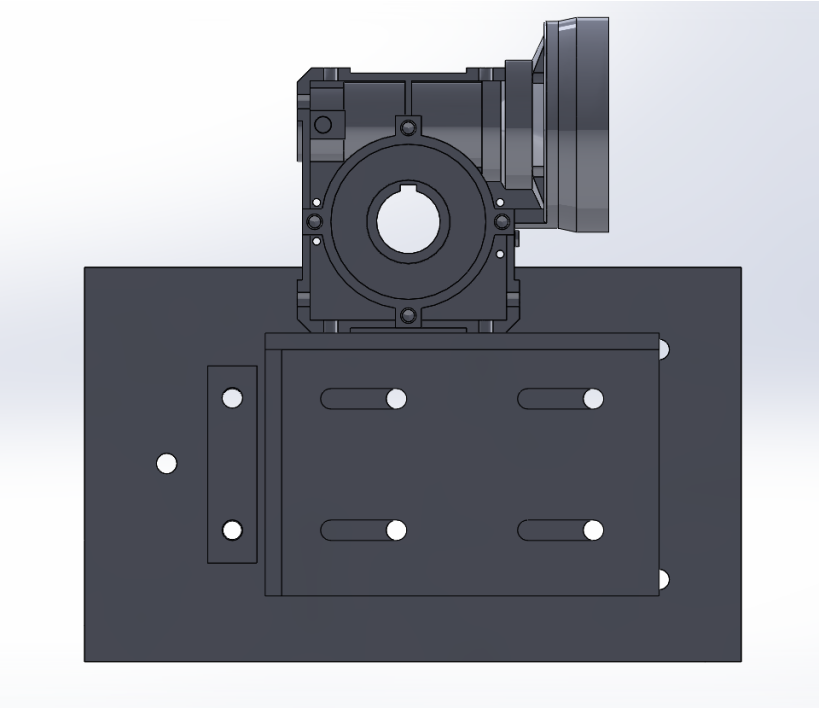

Figure 3: Front view of adapter plate with gearbox mounted.

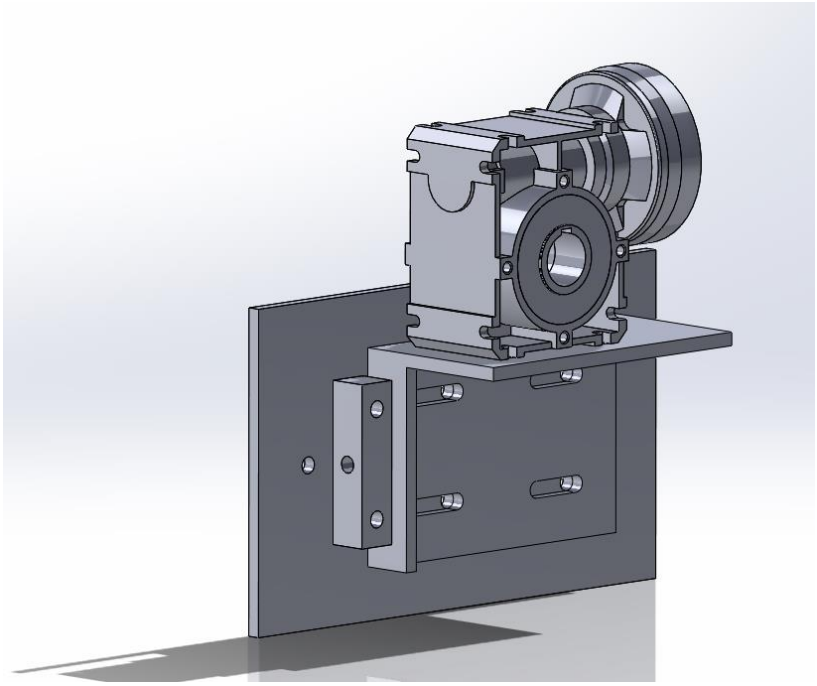

Figure 4: Isometric view of assembly.

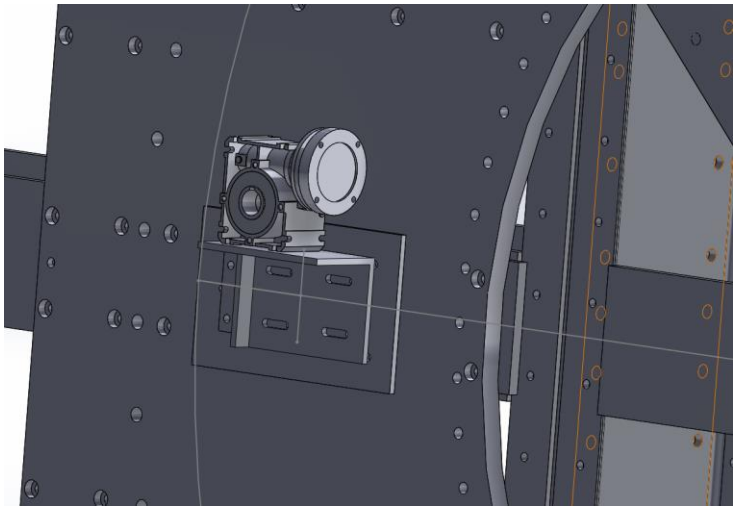

Figure 5: Assembly mounted onto test stand.

3.0 WINTER BREAK PROGRESS

Our group reconvened from winter break with a new strategy for the Orbital Test Stand project. Initially the group had selected a horizontal adapter plate where the motor and gearbox were mounted directly onto the plate, and the plate was mounted on the same plane as the test stand itself. However, after further examination we concluded that the design was going to need an L-shaped steel plate for the concept to be able to operate. The one-stage, reversible gearbox by Grainger takes an input from a motor and transitions that into lower RPM's at an output oriented at 90 degrees to the input. Due of this turn, and in order to have the sprockets and roller chain in the same

plane, the group redesigned the adapter plate to include an L shape so that the motor and gearbox could direct the lower RPMs back towards the test stand. This was the primary focus of the group's work over the winter break away from NAU. Refer to the above images for the updated concept.

4.0 2015 SCHEDULE

4.1 Hardware Review 1

For the first hardware review on February 10, 2015 the group will present one completed adapter plate. This will be considered a hard deadline and anything less than the completion of one set of plates will be considered unsatisfactory. A demonstration of the fit and function of a full assembly is desired but not necessary by the 1st hardware review due to the logistics related to ordering the components. If the group has not received the motors, gearboxes, and wheels at a minimum the adapter plate will be fitted with predrilled mounting hole.

4.2 Hardware Review 2

For the second of two hardware reviews on March 24, 2015, the team will have at a minimum one fully functional interior wheels design concept complete with the two adapter plates, a motor and gearbox assembly, as well as the spindle/tire assembly. Due to facility and machine availability it is highly likely that both assemblies will be complete in the absence of logistics issues.

4.3 Orbital Deadline

The team has identified April 1, 2015 as the final deadline in order to have a working concept at Orbital's testing facility. In April, the team will film the complete implementation and successful testing of the concept on the test stand, which will then be displayed at the UGRADS presentation.

4.4 UGRADS

The UGRADS presentation is on April 24, 2015 and the team has planned to have a short video to display the working concept at Orbital's testing facility in Chandler, Arizona. In addition, the team will produce and display a poster board illustrating the entire Orbital Test Stand project.

5.0 CONCLUSION

With the final design and major deadlines selected, the group feels strong going into the Spring 2015 semester. The next update for this project will be a mid-semester progress report, where the group will report on the status of the Hardware Reviews, and the overall concept itself.