Solar Tracking Structure Design

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Team 07

Progress Report 2

Document

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Introduction

Our team has been tasked with designing a solar tracking system. The team reviewed and made the necessary alterations to better accommodate the design. Not only did the team's design witness changes, but both our needs and objectives also changed. Currently, solar tracking systems available on the market do not include manuals on how these systems work and ones that do have operator's manuals that are confusing and difficult to understand. Due to this problem, the team has embarked on a new design objective. Our new objective is to design a solar tracking system that enables students to experience the fundamentals of solar tracking systems. In order to facilitate this, the solar panels need to be operated automatically and must also be operated manually, if the system should malfunction and/or fail. Since students will be doing hands on learning exercises, the system also needs to be relatively simple and user friendly. The system will be accompanied by an input panel. The input panel will allow users to input pertinent information that will operate the system.

Solar Panel Frame

We assembled the frame that will hold the solar panel as seen in **Figure 1** below. The frame was made out of angle bar with dimensions 71" X 48". Flat bar was welded onto the frame to add extra stability. A frame was made for each solar panel.

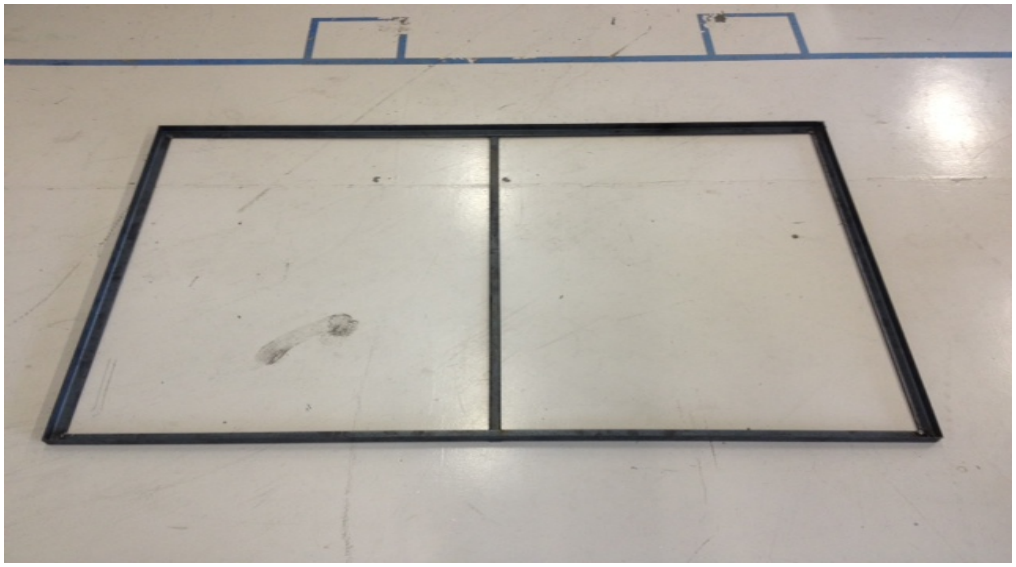

Figure 1: Solar Panel Frame.

Bottom Frame

The first thing we did was drill 18 holes for the manual North-South tracking. The next step was to cut the legs for our design. We originally cut 6 legs of 12 inch length based upon our final design. The 1”×1”×1/16” square tubing was cut at a 45^{o} for the widths of the bottom frame as well as the legs at the 4 corners of the frame. The bottom frame consists of two square tubing sections for the width of the frame of 72 inches and two angled bars for the lengths of the frame of 96 inches. After cutting all the pieces to the proper dimensions we got the frame welded by the student welders at the shop, since we are not allowed to weld in the shop due to legal issues. The frame was welded together on a Friday by two members of our team and the machine shop staff. However, when we came in on Tuesday we discovered that one of the sides with pivot holes was welded backwards. Two legs were also welded onto the frame one inch shorter than the 4 corner legs in the middle of the lengths of the square tubing instead of the angled bars and the middle support beam was not welded into place. We had two options the first being to just drill 18 more holes backwards on the square tubing, which would have resulted in improperly spaced holes. Or the second being to cut the backwards section and flip it and re-weld it to the frame. We decided to cut the section and flip it, however to ensure that the tubing stayed structurally strong we had to weld two small square sections of solid steel into the holes where the cuts were made as seen below in **Figure 2**

Figure 2: Fixed welded joint for square tubing

Then we also welded two legs into the middle of angled bar as well as welding a section of square tubing in the middle of the angled bar. The full assembly of the bottom support is shown in **Figure 3** below.

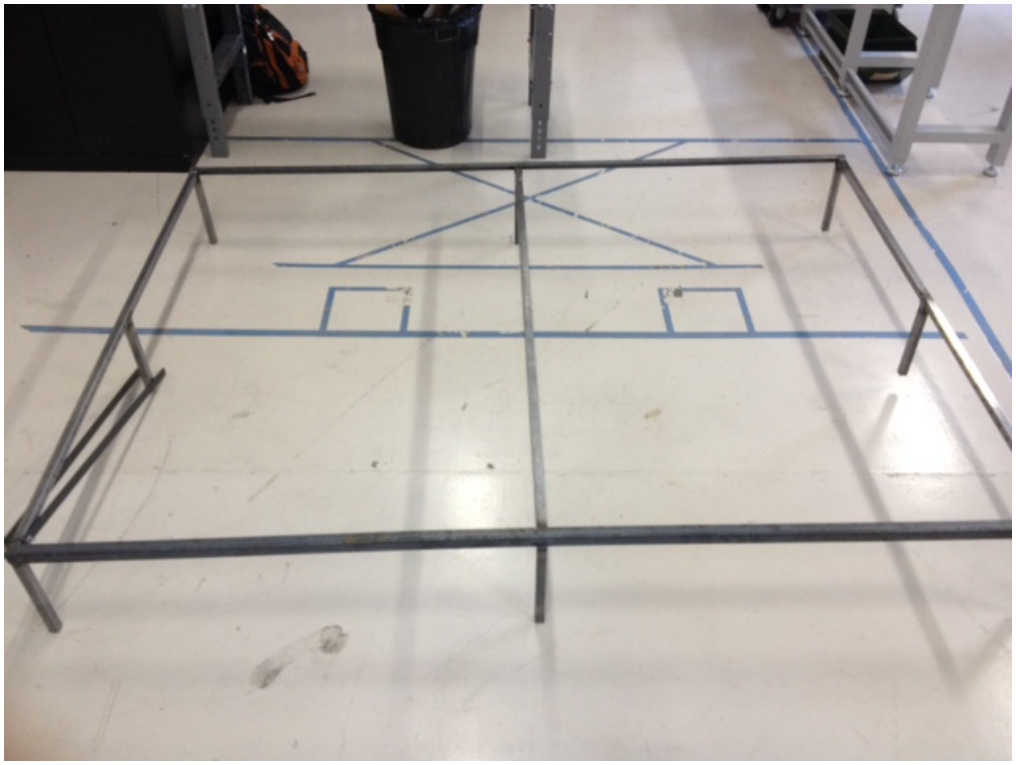

Figure 3: Bottom support Frame

With the frame finally built correctly we got some sheet metal that was ¼ inches thick and cut 6 square feet for the legs with dimensions of 4”×4” as well as 2 feet with dimensions of 3”×3” for the extra legs that were welded onto the frame as seen in **Figure 4** below.

Figure 4: square sections for leveling pads

Pivot Hole and Pin Tracking

By Dr. Acker's request our solar tracking system has the capability to manual track the sun North-South axis of rotation. The tracking system has a pin and hole system to move the panels at different angles every 10 days. The panels can lay almost perfectly flat and has the range of 60 to 30 degrees with 18 increments two inches apart to better track the sun. For the best results to track the sun move the panels one hole every 10 days, increasing the angle as the as the days grow shorter and decreasing the angle as the days grow longer. Pivot hole and pin tracking is seen in **Figure 5 and 6** below.

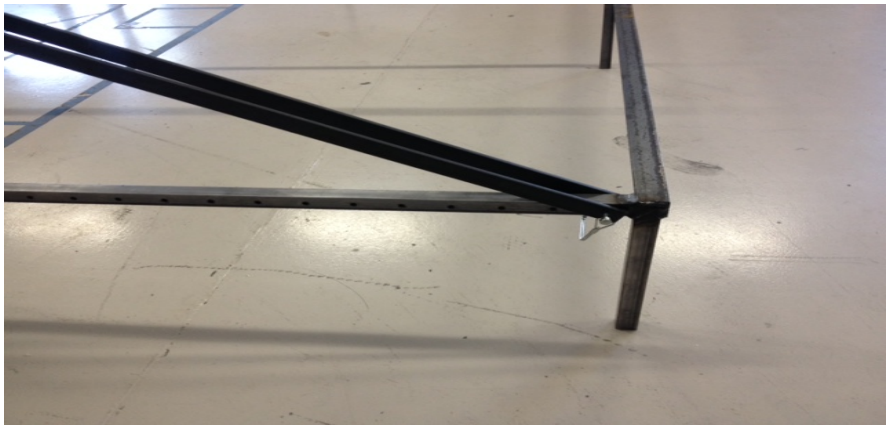

Figure 5: Pivot Hole and Pin

Figure 6: Side view of pivot and top frame system

Worm Gears and Shafts

The worm gears were purchased and have arrived. A 1” diameter bar was cut in 7 inch segments then grinded down for a more appropriate fit in the mounted bearings and gears. The finished product is seen below in **Figure 7.**

Figure 7: Worm Gears and Shafts

Hydraulic Stabilizer

The hydraulics were purchased from an auto parts store. Each of the hydraulic stabilizer is rated to hold up to 150 lbs. The holes for the hydraulics were drilled into the 1”×1” ×1/16” square tubing. A picture of the hydraulics and bolts to be used is shown below in **Figure 8**.

Figure 8: Hydraulic Stabilizer

To make the angle adjustment easier and safer, a car hood hydraulic stabilizer is installed close to the pivot point to provide the extra support to the solar panel. The precise location of the hydraulic stabilizer wasn't included in the solid works design since it depends on the size of the hydraulic stabilizer. Once we purchased the hydraulic stabilizer which has a 12.75 in fully extended length and 7.1 in contracted length**. Figure 9** shows the triangle that the stabilizer and the frame will create. Point A and point C indicates the locations where the stabilizer is installed. Point D indicates the pivot point. Point B is where the point A will reach if the solar panel is laid flat. The triangle can be solved using the dimensions of the stabilizer. The distance CD turns out to be 7.62 in. and the distance AD turns out to be 14.72 in. These calcuations were done at the largest angle of 60^{o} which is not reflected in **Figure 9.** The force needed to contract the stabilizer is about 10 lb. If the stabilizer is installed in the right place, it should be contracted easily with the weight of the solar panel itself.

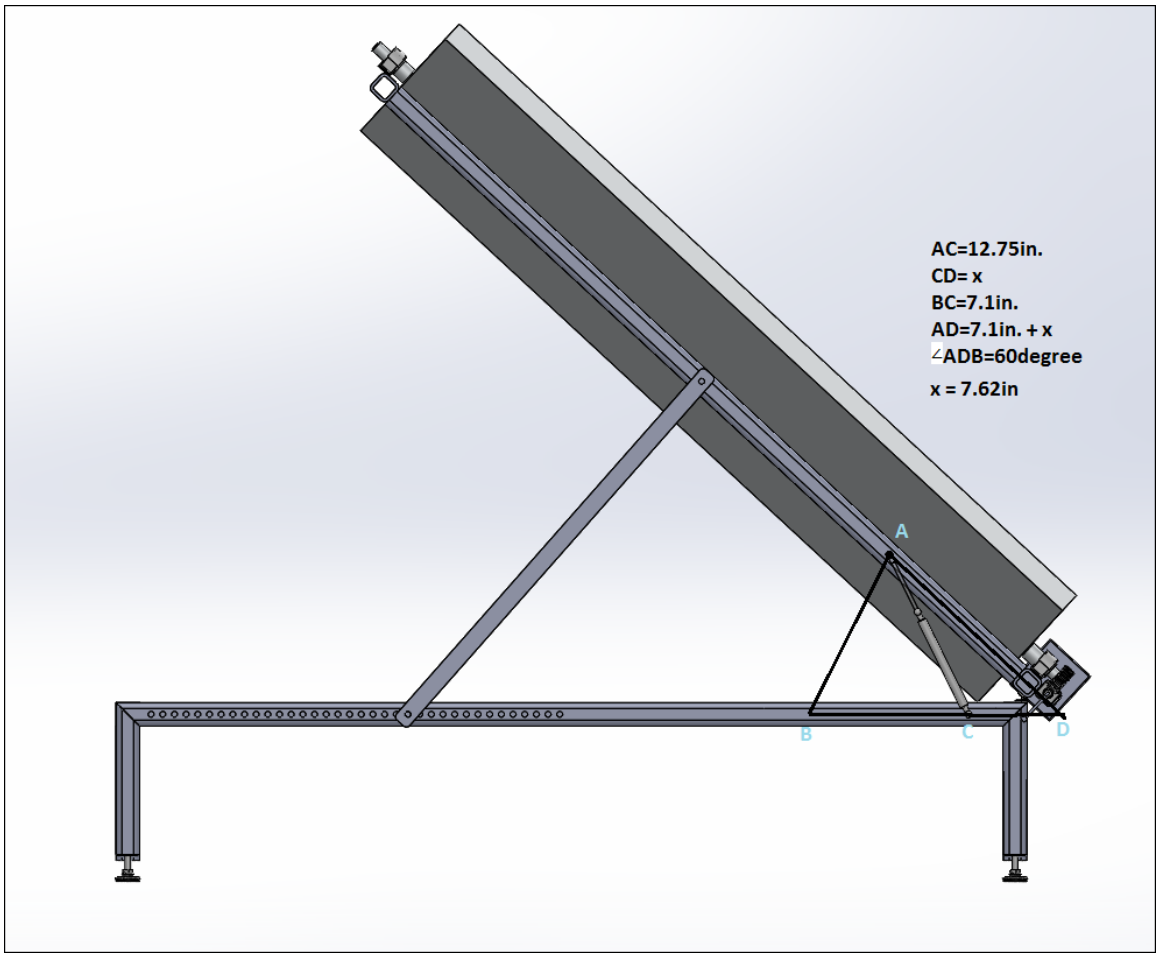

Figure 9: Hydraulic hole location calculation

Mounted Bearings/Hinge Assembly

Currently we have not actually welded the mounted bearing sections onto the top frame of our design because we ran into a couple of problems regarding the hinges and motor placement onto our system. For the bottom part of the top frame where the gears and motors will go we ran into the issue of spacing in between the mounted bearing housings and the hinges. Originally we were going to just bolt the bearings into place on the top frame, however we realized that during movement of the North-South tracking system we would run into the angled bar on the bottom frame if the bolts are exposed. So after talking to the welders in the machine shop they suggested that we should drill 2 holes all the way through the square tubing and then insert the bolts as normal and fix the nuts onto the top of the mounted bearings. Once that is done they suggested that we cut the bottom of the bolt off and weld the threaded section of the bolt in

place so that the bolt head does not interfere with the angled bar on the bottom part of the frame. The proposed build for the bottom mounted bearings is seen below in **Figure 10**.

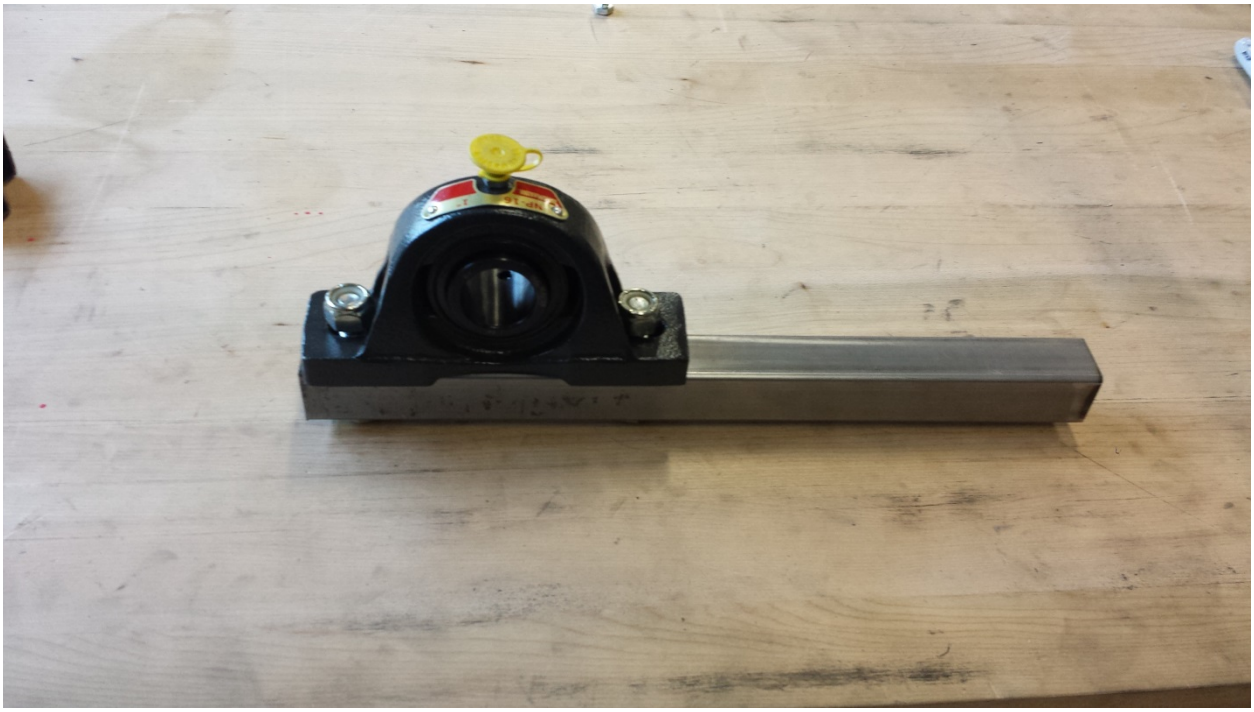

Figure 10: Proposed bearing build

Gantt Chart

Figure 11: Previous Gantt Chart for spring 2014

The **Figure 11** above is of our previous Gantt Chart from the beginning of this semester. When the team started executing the tasks on the list, it took more time than we expected to build the solar tracking system. In order to make sure the project will be done on time the team updated the Gantt Chart which clearly shows the changes of the schedule as seen in **Figure 12** below.

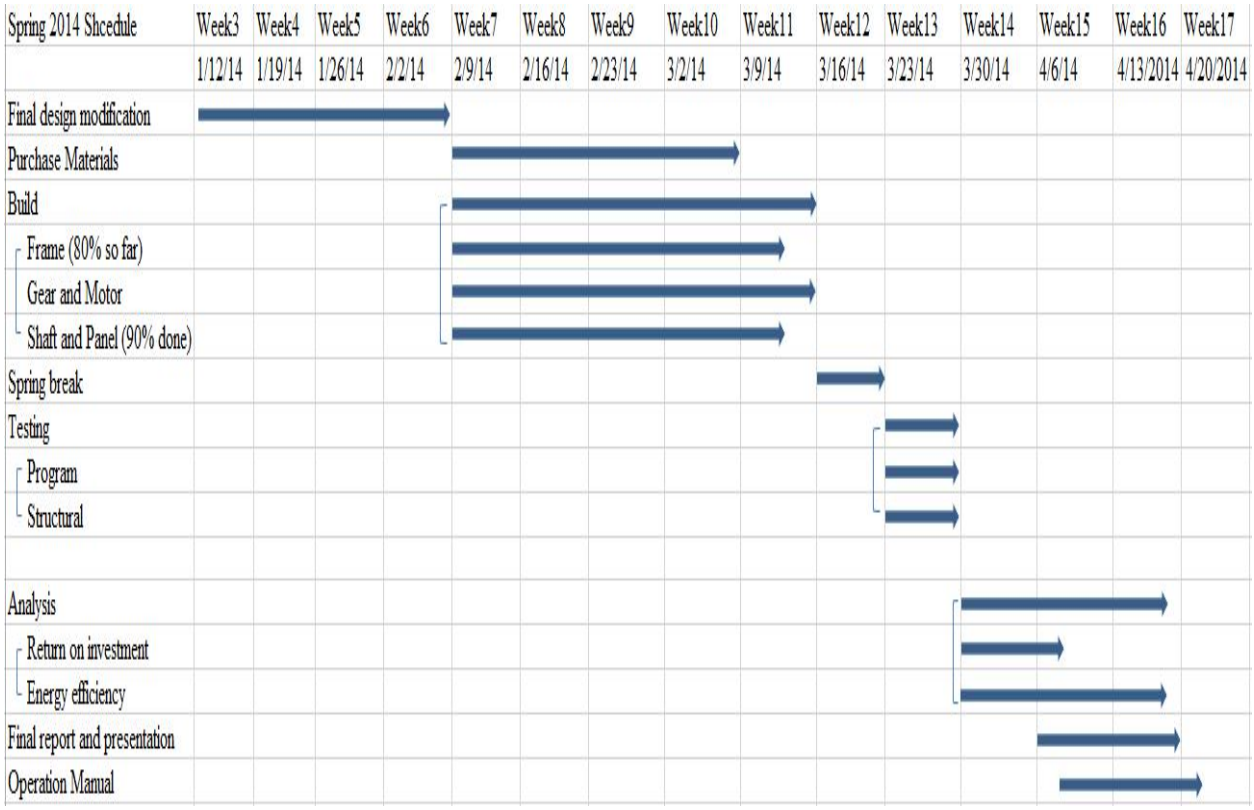

Figure 12: Updated Gantt Chart for spring 2014

The design modification process is going to take the team one more week than originally planned, the materials purchasing process was postponed until week 7 because our budget required authentication by our client. The building process started at week 7. At the end of week 10, the team has finished the bottom and top frame. The gears have arrived and 2 control systems and one motor are on their way. One of the motors is on back order for 1 week. The team is going to get the building process and structural testing done before week 12. On week 13, team members will start writing the program for the tracking system and get the program testing done. The testing is projected to take 7 days to finish. Upon return the analysis of the solar panel system will be initiated as well as the analysis of the efficiency of the system. Team members will start writing the final report, presntation, and operations manuel in week 14 and will be finished by week 17.

Conclusion

In this report we went over the sections of our design which we have completed at this point in time. We provided information on how we built the different sections of our design as well as problems we have run into. The team has completed the bottom frame and box frame for solar panels and the angle supports are ready to be assembled. Due to the motors not being here yet the construction of the gear, motor assembly has not been completed. We were also wondering how to get the solar tracking system to the shack; however we have decided that we will leave the system at the machine shop until the U-Grads presentation when it has to be moved anyway. The Gantt chart has been updated to account for the unforeseen delays and to help the team finish the project on time. The analysis dates have not changed because of these unexpected problems. The final report and presentation are to be presented to Dr. Raju on April 17th. An operation manual for the solar tracking system will be available by the end of the semester.