

Solar Tracking Structure Design

By:

Hashem Bukhamsin, Angelo Edge,

Roger Guiel, Dan Verne

Team 18

Midpoint Review

REPORT

Submitted towards partial fulfillment of the requirements for

Mechanical Engineering Design I – Spring 2014



Department of Mechanical Engineering

Northern Arizona University

Contents

1. Introduction	3
2. Goal Statement	3
3. Design	3
Figure 1: Solar Tracking Design	4
4. Cost Analysis	4
Table 1: Current Cost	4
5. Current Progress	5
Figure 2: Design Progress.....	5
Figure 3: Solar Panel Frame	6
6. Testing	6
Figure 4: Weight Test	6
7. Project Plan	6
Figure 5: Gantt Chart.....	7
8. Conclusion	7
References	7

1. Introduction

Solar energy is increasing in popularity throughout the world. Germany continues to lead the world in solar power production while breaking its own records year after year [1], despite the nation's perpetual cloud cover, and Saudi Arabia has pledged to reach a solar energy capacity of 41 gigawatts within the next 20 years [2]. There is an excellent potential for solar power production in many locations throughout the United States, and there are a number of means of application.

Solar power production is usually accomplished using one of two methods. The first method utilizes Photovoltaic (PV) cells to convert sunlight into an electric current by the means of the photoelectric effect, in which a material absorbs electrons after receiving energy from a light source. A photovoltaic cell takes advantage of this effect by harnessing the electron flow in the form of direct current electricity. The second method of solar energy power production is the Concentrated Solar Power (CSP) method. CSP generation uses mirrors to concentrate sunlight into a specific spot. Unlike the PV method, the goal of the CSP method is to produce heat in order to drive a heat engine. Electricity is produced via a generator connected to the heat engine. This project will be focusing on the use of PV cells.

2. Goal Statement

Northern Arizona University offers several classes on renewable energies, and has its own area behind the Engineering building where several solar panels and wind turbines are stored. This project is going to be given access to four photovoltaic panels to fit the tracking system to. Along with the tracking station, this project also incorporates an educational component. The tracking system should have a manual override so the instructor can direct the solar panels in whichever direction they desire. The system should also display the power output of each individual photovoltaic cell, to show the efficiency at each angle.

Moreover, the team will participate in a competition against other universities designs. This competition will take place in New Mexico State University. Therefore, our team has made it one of the primary goals to participate and win the event. The creativity and efficiency of the design will also be major evaluation criteria. Furthermore, our team has been and will continue working alongside the Electrical Engineering (EE) team. Our team works on the structural design and the EE team will provide us with the tracking mechanism and the programming needed to operate the system. Both of our teams will work and cooperate together to ensure the success of this project.

3. Design

Figure 1, located below, is the team's concept design for the solar tracker. The design is cheap, efficient, and well exceeds the load required to hold/rotate two solar panels.



Figure 1: Solar Tracking Design

The solar tracker design does not require any welding. Every piece is attached via nuts, washers, and bolts. The movement of the solar panels is done by using a linear actuator. The linear actuator is connected perpendicular to the solar panel frame and can rotate freely as it applies force to the solar panel frame. This increases the linear actuators range of motion thus increasing the amount of solar panel tilt.

4. Cost Analysis

Table 1: Current Cost

Part	Price (\$)	Count	Total (\$)	Source
1" Pillow Bearing	11.25	2	22.5	VXB.com
18" Linear Actuator	99	1	99	ECO-Worthy
1" Elbow	17.74	2	35.48	Hardtofinditems.com
1" Tee	36.99	2	73.98	Hardtofinditems.com
120" 3/4" Conduit	3.87	2	7.74	HomeCo
36"x1/8" Flat Steel	8.21	2	16.42	Home Depot
Square Steel Tube	16.21	2	32.42	Home Depot
1 1/4" PVC Tubing	2.35	3	7.05	Home Depot
Misc. Nuts and Bolts	10	1	10	Home Depot
60" U bar	16.09	1	16.09	Home Depot
36" Steel Angle	12.47	1	12.47	Home Depot
Total			333.15	

Currently, the team is under the projected budget for the construction of one solar tracking structure unit. This is due to the implementation of the 3/4" conduit. It is much cheaper than the previously selected steel while being stronger than needed.

5. Current Progress

Figure 2 is the team's current progress on the solar tracker. The solar panel frame still needs to be constructed. Once the solar panel frame is constructed, the connection between the bottom frame and the solar panels can be completed.



Figure 2: Design Progress

The base frame was constructed by drilling 3/8" holes at the end of two equal pieces of square tubing. Two additional 3/8" holes were drilled into two equal lengths of flat panel steel. Nuts, washers, and bolts were then used to connect the four pieces of steel, creating a square frame. Upon constructing, the team realized that the base frame was collapsible by losing the bolts. This gives the solar tracker an extra design feature, easy to store and maneuver.

Eight square brackets were then cut to hold the circulate tubing. The square brackets were placed over the preexisting holes used to connect the base frame. Four circular tubes, when placed between each of the brackets, create a sturdy triangular shape. Elbows were then placed over both triangular shapes. Additional pieces of PVC were used to connect the elbows to the metal conduit. The PVC was initially used because the metal conduit was too small for the elbows. The team found that by adjusting the size of the PVC between the elbows, the North-South axes could manually be changed.

Figure 3, is an image of the back of one of the solar panels used for this design.



Figure 3: Solar Panel Frame

Holes are already placed on the solar panels to be used as mounting. The team will use a U-Channel to connect the solar panel to the frame. The connection between frame and solar panel will be accomplished by using washers, nuts, and bolts. The solar panel frame will then be mounted to the pillow bearings. The pillow bears are located on the axis of rotation. Completing the solar panel frame is the last major task to be accomplished by the solar tracking team.

6. Testing

The team has already tested the solar tracker, excluding the solar panel frame. Figure 4 depicts a team member displacing all of his weight over the middle of the solar tracker. The team member weighs roughly 150lbs. This load well exceeds the loads created by the solar panel, frame, and even apocalyptic weather conditions. The actuator was temporarily attached via cabling to the solar tracker. The linear actuator was able to rotate the frame over the full range needed to track the sun efficiently.



Figure 4: Weight Test

The next test to complete is a full scale test with the solar panels attached. This test concludes the testing of the structure for the solar tracker.

7. Project Plan

Figure 5 below, is the teams Gantt chart for the spring semester. The Gantt chart has changed from previous meetings. The dates for constructing the solar panel frame have been extended. This in turn affects the amount of time we previously allocated for testing.

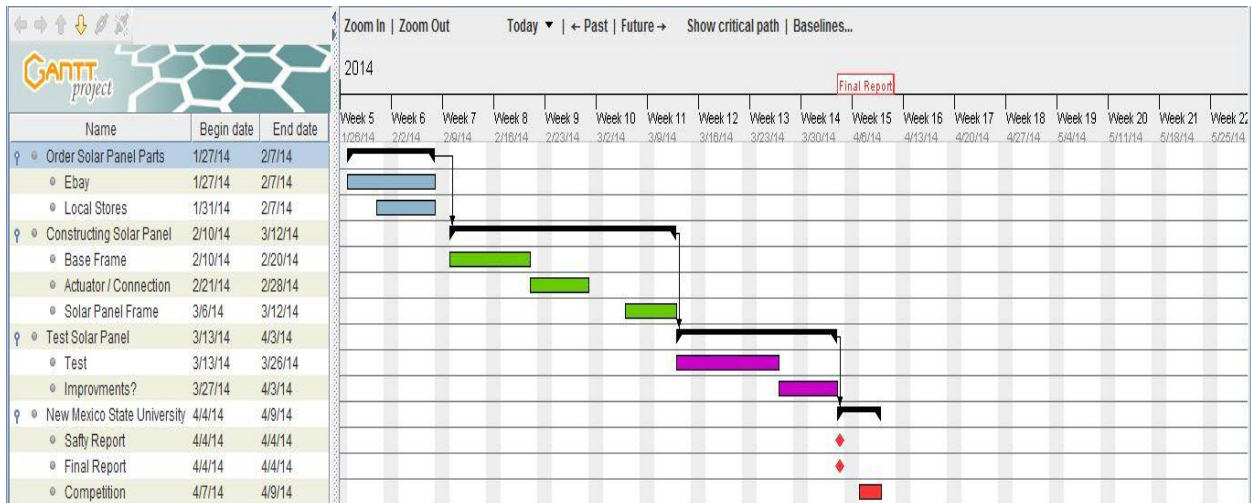


Figure 5: Gantt Chart

The solar panel frame is to be completed before the Friday going into spring break, March 14th. This allows the team roughly three weeks to make any additional changes. The testing and potential changes would ensure the quality and efficiency of Solar Tracking Team B's design.

8. Conclusion

The design of the structure is meant to satisfy the competition needs and requirements. The objectives are to design a system that is both inexpensive and durable. After finalizing the system design, our team has ordered and bought all the parts needed to build the system. All the parts have been received. Then, our team started the building process of the system and has assembled the base of the structure along with the triangular support for the main shaft of the system. Moreover, the actuator has been attached to the structure. The structure has been tested for strength by placing weight on it. The control system box is yet to be built. After the assembly of the system is fully completed, we will work with the electrical team to finish the tracking mechanism along with the electrical connection. According to the project plan, all tasks will be completed in time to participate in the competition.

References

- [1] <http://thinkprogress.org/climate/2013/08/22/2508191/germany-solar-generation-record/>
- [2] <http://www.dailyfinance.com/2013/11/16/solar-in-saudi-arabia/>