Solar Tracking Structure Design Engineering Analysis

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Overview

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- Solar Panel Specifications
- Maximum Loadings:
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Introduction

- “Dual axis tracking provides a 35-40% increase in efficiency to static and a 3-8% increase from single axis.”
- Solar Panel Specifications

  Model KC130TM

  56.1 X 25.7 X 2.3 inches

  130 Watt Max Power Output
- Sponsor

  Dr. Tom Acker

Snow Weight

Assuming panel parallel to ground for maximum stress

Maximum Estimated Snow Load: **6in. compact snow & 30in. fresh snow.**

Maximum Snow Load Height: 36in.

Estimated Volume of the Snow Load: 36in.x56in.x25in.

56.1in x 25.7in = 1441.77in^2

Total weight of snow = **198lbs**

Wind Load

Assuming panel perpendicular to ground for maximum stress.

Force=Area*Drag Coefficient*0.00256*Wind Velocity^2

Drag Coefficient = 2

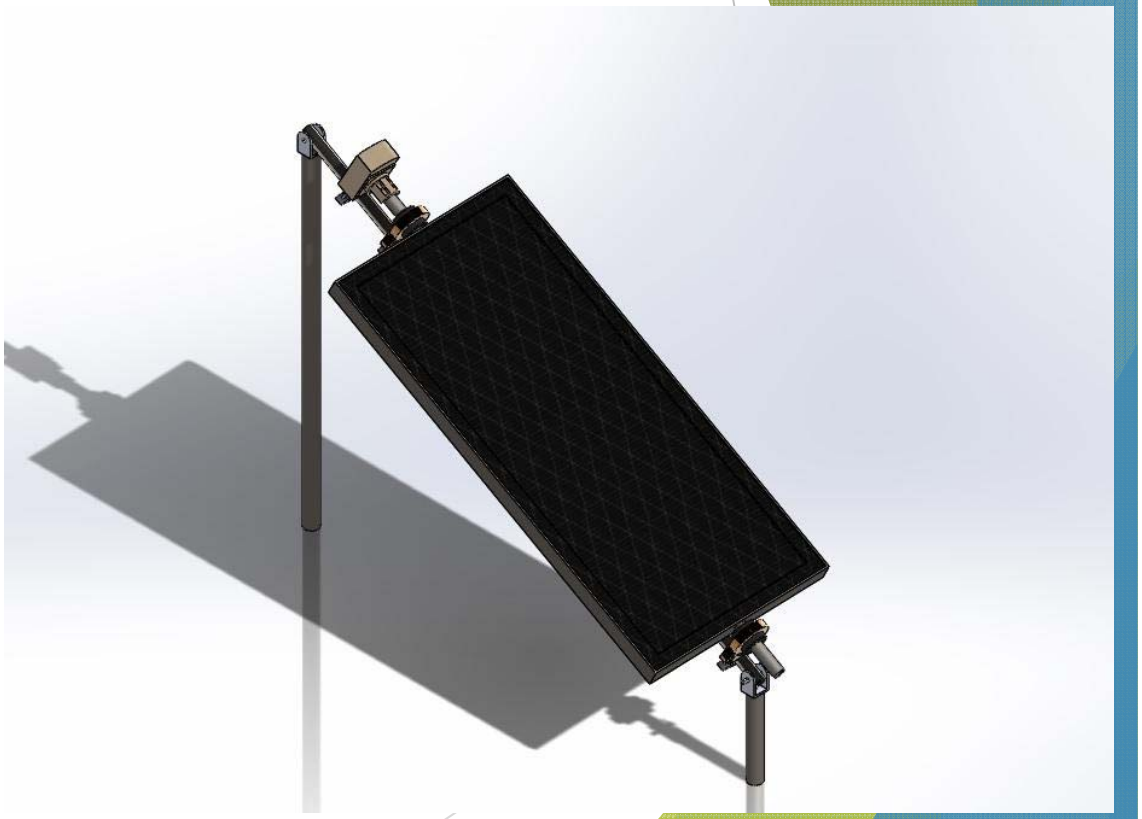
Area= 1400 in^2

Wind Velocity = 65 mph

Total Wind Load = 210 lbs

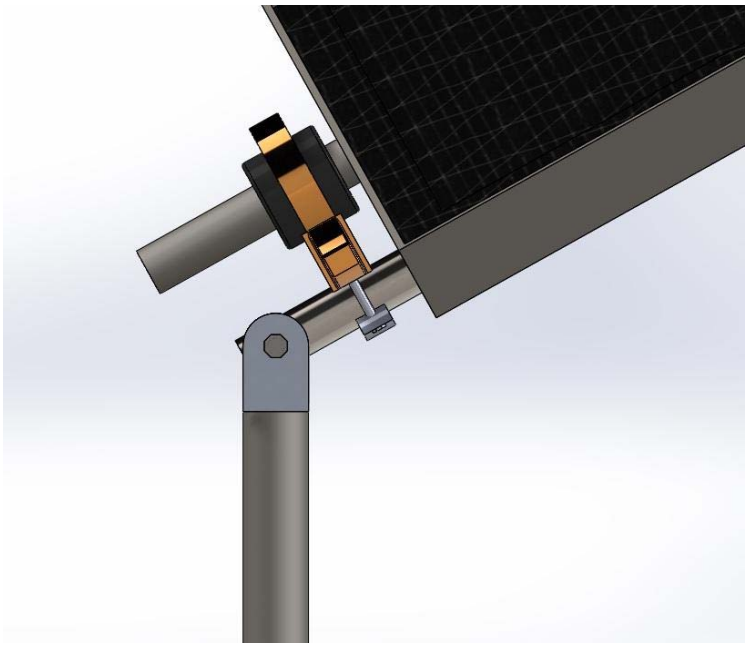
Design 1- The Rotisserie

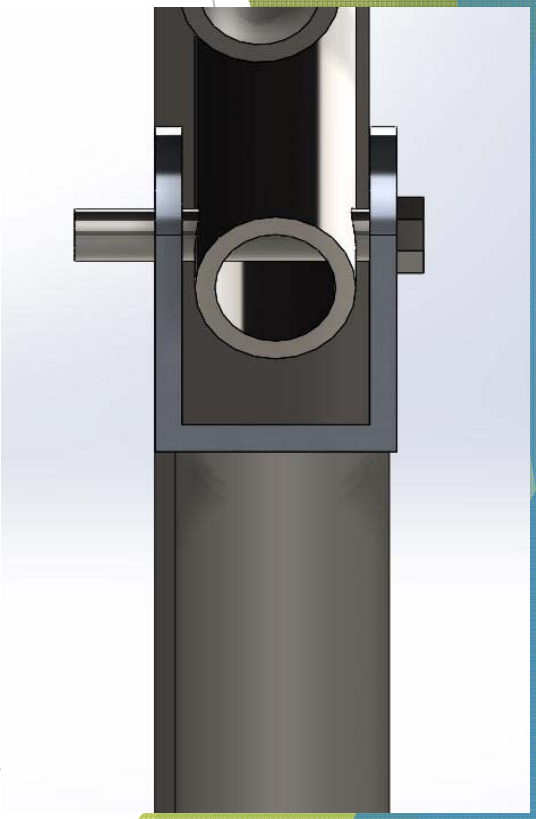
- Single axis tracker with room for an additional axis.
- Super efficient due to the solar panel being directly on the axis of rotation.
- Simple design and cheap to build.



Rotisserie Key Stress Areas

- Hinge Bolt
- Support Bar
- Frame (Due to its small thickness)
- Frame Weld



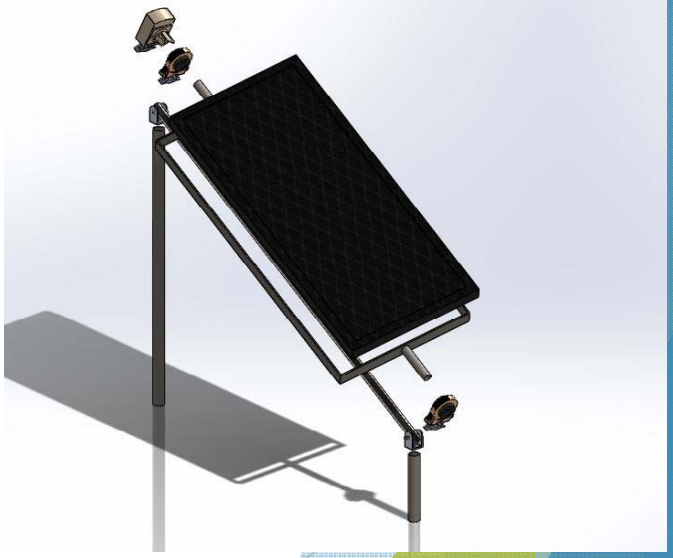


Rotisserie Static Stress Analysis

Stresses	Material	Yield Stress (Ksi)	Maximum Stress (Ksi)	FOS
Hinge Bolt (0.5")	Steel	70	5.03	7.0
Support Bar (1.5")	AISI1020	60	5.2	11.4
Frame (1/8" thick)	AISI1020	60	30.6	4.0
Frame Connection	Weld	50	17.5	2.9

Rotisserie- Cost and Parts List

Cost Analysis	Units	Comment	Cost/unit	Cost
Motor	1	Antennacraft TDP-2	$62.99	$62.99
Bearing	2	TB-105 Support	$35.95	$71.90
Axle Bolt	2	0.5" x 4"	$2	$4.00
1.5" Pipe Flange	2	Home Depot	$2	$4.00
2" Pipe Flange	2	Home Depot	$2	$4.00
Flange Bolt	16	Home Depot	$0.75	$12.00
Pipe Hinge	2	Still Shopping	$10	$20.00
2" Base Pipe	1	8 ft, cut down	$35	$35.00
1.5" Support pipe	1	7 ft	$35	$35.00
1/8" x 2.5" Flat bar	1	13 ft at $9/72"	$19.50	$19.50
			Total	$268.39



Rotisserie- Power

Motor Provides 8 ft*lbs of torque using 65 Watt

$T = (\alpha)*I$

$I = (1/12)m*width^2 = .3324$ slug* ft^2

Provides an angular acceleration of 24.07 rad/s^2

"Much more than needed, but motor rotates at **5.14 (deg)/s**."

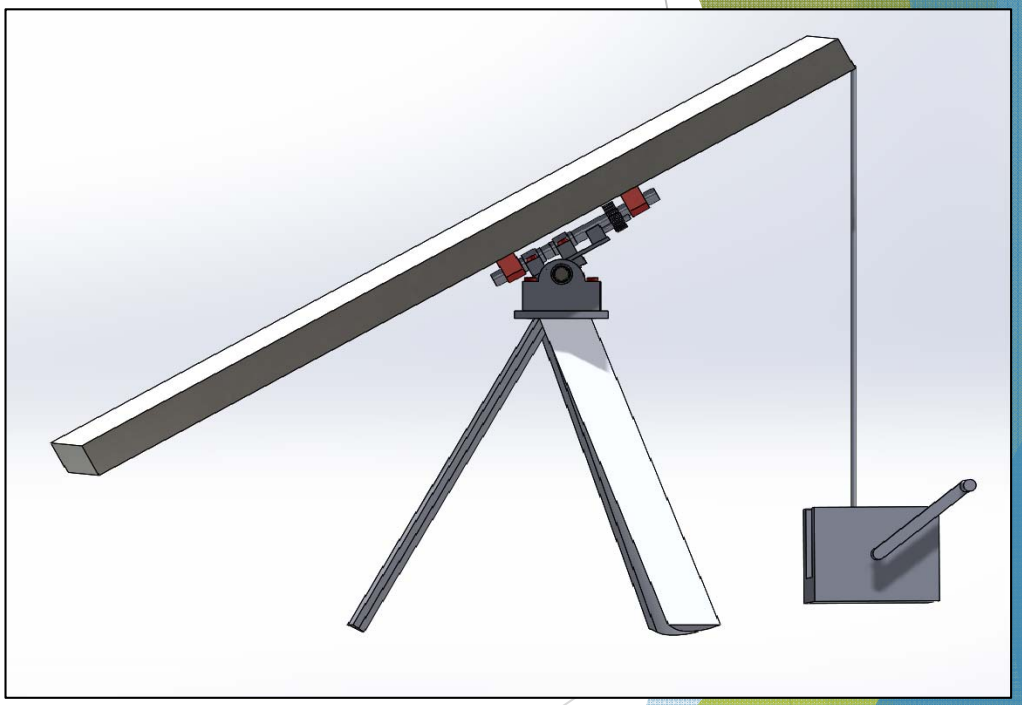
Running the motor in 5(deg) intervals, about 1 second, at 65 Watt

360(deg)/5.14(deg)/s = 70 s per day = 7.1 hrs/year

At 65 Watts, gives **0.4615 kWh/year**

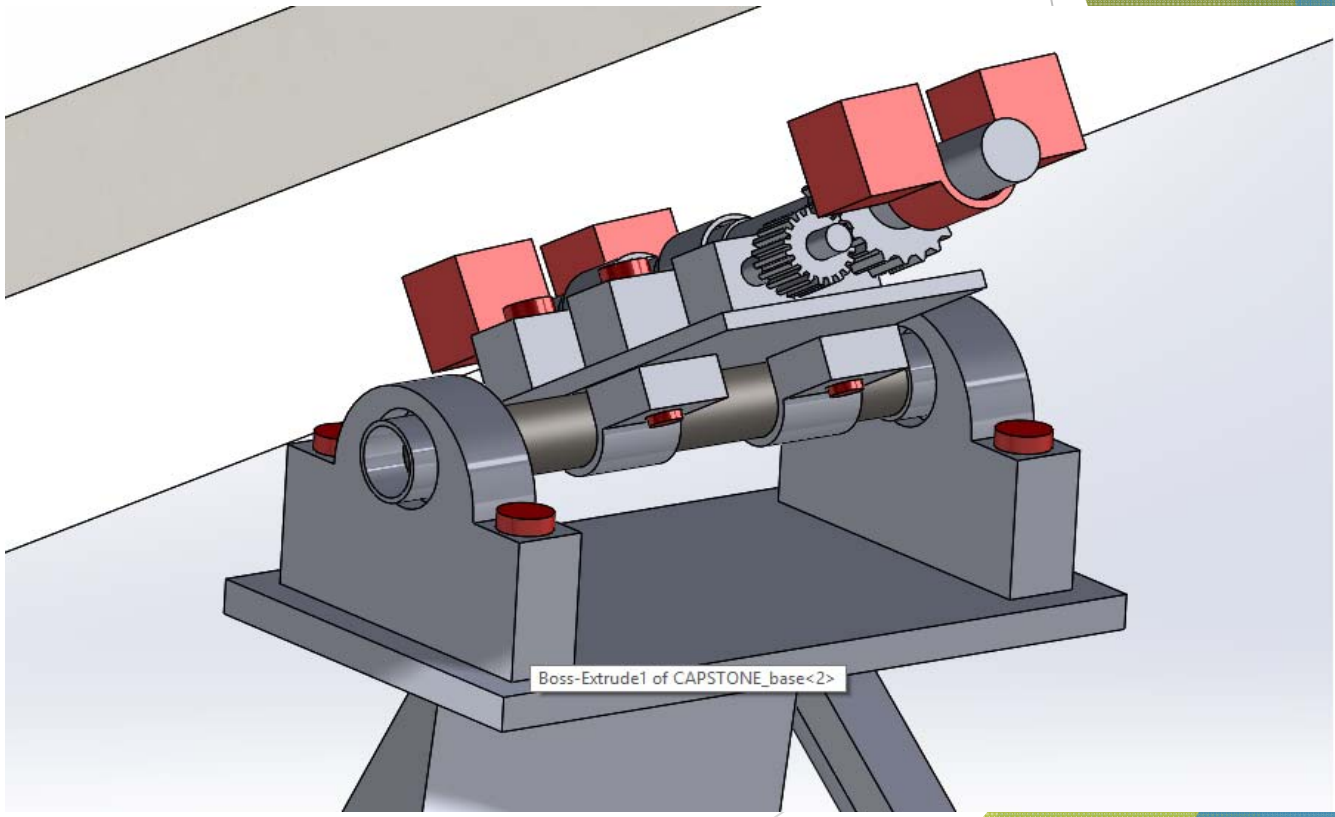
Design 2-Modified TIE Fighter

- Dual axis.
- Manual North and South rotation.
- Motor and gear East and West rotation.
- Simple and robust



Tie Fighter Stress Areas

- Bolts.
- Frame Welds
- Cable Tension
- Gears.



Tie Fighter Static Stress Analysis

Stress Analysis Points	Material	Yield Stress (Ksi)	Maximum stress(Ksi)	FOS
North and South bolts	AISI 1010	25.5	4.3	5.9
Welds on the panels box	AISI 1020	50	0.096	106
Cable	Galvanized Aircraft	2.6	.64	4
Gears	polyoxymethylene	2	10	5

Tie Fighter Cost and Parts List

Material	Units	Comment	Cost/unit	Cost
Motor	1	Antennacraft TDP-2	$62.99	$62.99
Bearing	4	TB-105 Support	$35.95	$143.80
Bolts	8	Home Depot	$0.16	$1.28
1/8" Pipe Strap	2	Home Depot	$2	$4.00
Gears	2	Amazon	$7	$14.00
Winch	1	Amazon	$20	$20.00
1" Base Pipe	2	8ft., cut down	$35	$70.00
Cable	1	13ft. at $9/72"	$0.08	$0.32
Plates	2	Still shopping		
Tripod	1	Still shopping		
			Total	$316.39

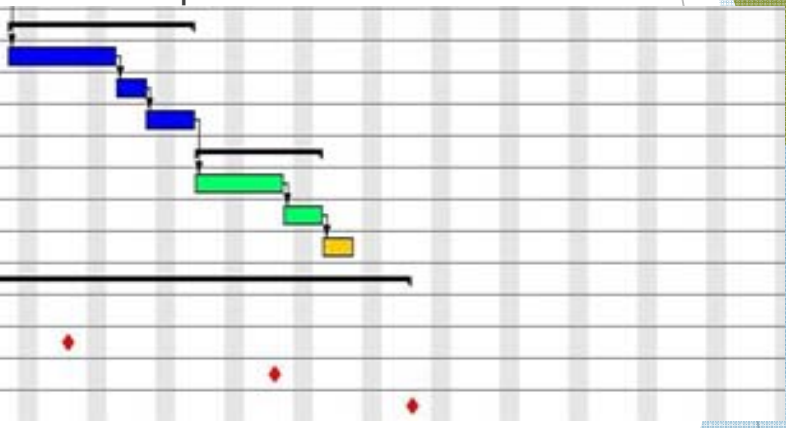
Competition

- Currently, the designs are tailored to New Mexico competition. I.E. max efficiency for the lowest cost.
- After the requirements for the competition are solidified with the Electrical Engineering team, the designs can be redone to fit the needs of Flagstaff.

Original Team Schedule

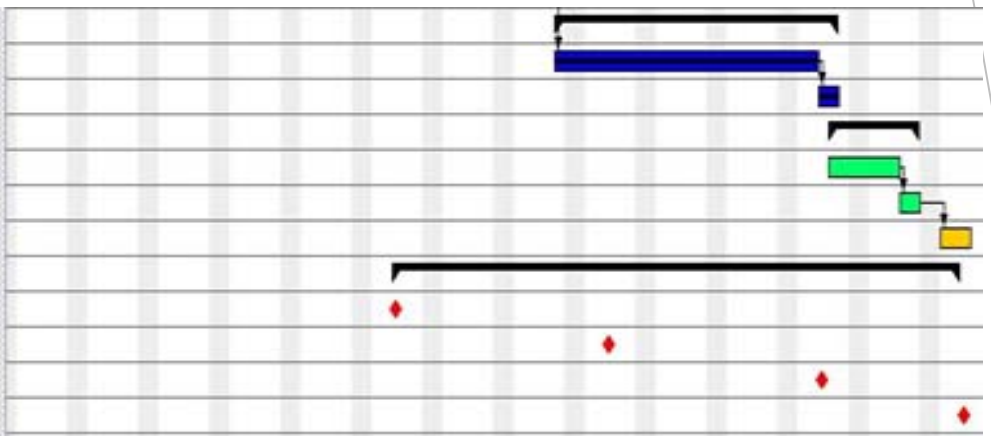
Updated

Analysis	10/25/13	11/12/13
Engineering Analysis	10/25/13	11/4/13
Cost Analysis	11/5/13	11/7/13
Program	11/8/13	11/12/13
Prototype	11/13/13	11/25/13
Build Prototype	11/13/13	11/21/13
Test Prototype	11/22/13	11/25/13
Finite Design	11/26/13	11/28/13
Presentation / Reports	10/9/13	12/4/13
Project Plan	10/9/13	10/9/13
Concept Generation and Selection	10/30/13	10/30/13
Engineering Analysis	11/20/13	11/20/13
Final Presentation Project Proposal	12/4/13	12/4/13



Adjusted Team Schedule

Analysis	10/25/13	11/21/13
Engineering Analysis	10/25/13	11/19/13
Cost Analysis	11/20/13	11/21/13
Prototype	11/21/13	11/29/13
Build Prototype	11/21/13	11/27/13
Test Prototype	11/28/13	11/29/13
Finite Design	12/2/13	12/4/13
Presentation / Reports	10/9/13	12/3/13
Project Plan	10/9/13	10/9/13
Concept Generation and Selection	10/30/13	10/30/13
Engineering Analysis	11/20/13	11/20/13
Final Presentation Project Proposal	12/4/13	12/4/13



Conclusion

Solar Panels - Model KC130TM

- Size: 56.1in x 25.7in x 2.3in
- Weight: 28 lbs

Maximum Loadings on the Solar Panel

- 198lbs from snow
- 210lbs from wind

Design 1- Rotisserie

- Efficient- $270 to build and $0.10 per year to run
- Smallest factor of safety 2.9 on frame weld

Design 2- Modified TIE Fighter

- Unsure if efficiency is worth extra cost

Competition

- Deigns focused on the New Mexico Solar Competition
- EE team working on the actual tracking of the designs

References

[1] http://www.kyocerasolar.com/assets/001/5186.pdf

[2] Hibbeler, Engineering Mechanics Dynamics, Thirteenth Edition ed, Upper Saddle River, New Jersey: Pearson Prentice Hall, 9-25-13.

[3]http://www.homedepot.com/p/Unbranded-1-1-4-in-x-48-in-Plain-Steel-Flat-Bar-with-1-8-in-Thick-42180/100337615?cm_mmc=shopping-_-googleads-_-pla-_-100337615&skwcid&kwd=&ci_sku=100337615&ci_kw=&ci_gpa=pla&ci_src=17588969#product_description

[4]http://www.starkelectronic.com/nterotor.pdf

Questions?