# Solar Tracking Structure Design

## Analysis of Concepts

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# Presentation Outline

- Introduction to the project
- Solar tracking angle analysis
- Three designs with analysis
- Updated project plan
- Conclusion

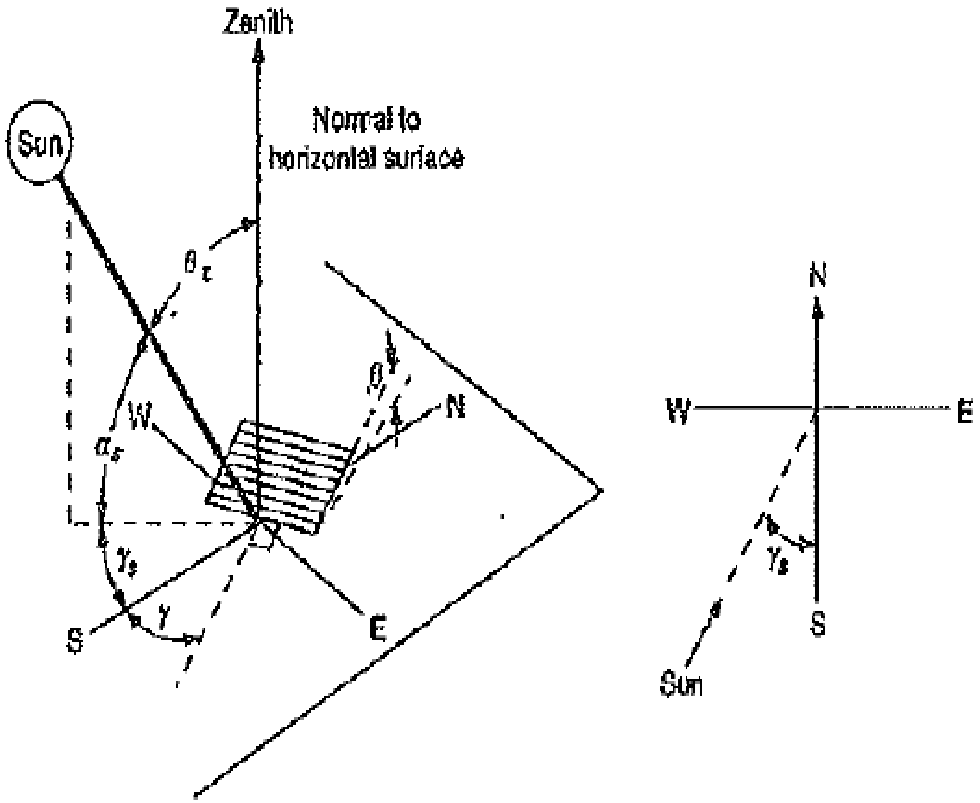
# Project Introduction

- Need
  - Current solar tracking systems are expensive unreliable and hard to maintain.
- Objective
  - Design an efficient yet reliable solar tracking system.
- Sponsor
  - Dr. Tom Acker
- Testing environment
  - Will be tested with existing fixed solar panels

# Solar Tracking Angle Analysis

- Most important angles
  - Solar azimuth (Ƴs)
  - Angle of Incidence (Ɵ)
  - Panels slope angle (β)
- Tracking systems are supposed to
  - Minimize angle of incidence (Ɵ)
  - Maximize angle of incident beam radiation

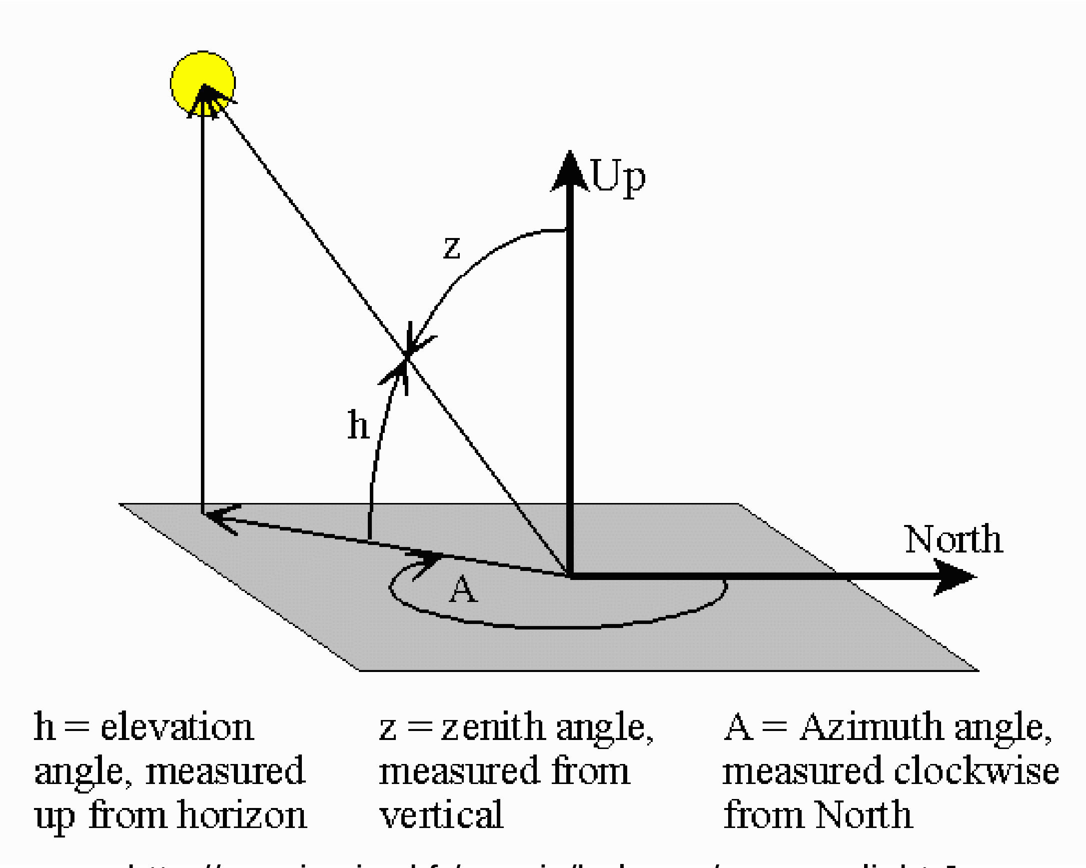
All angles required for analysis



# Solar tracking Analysis cont.

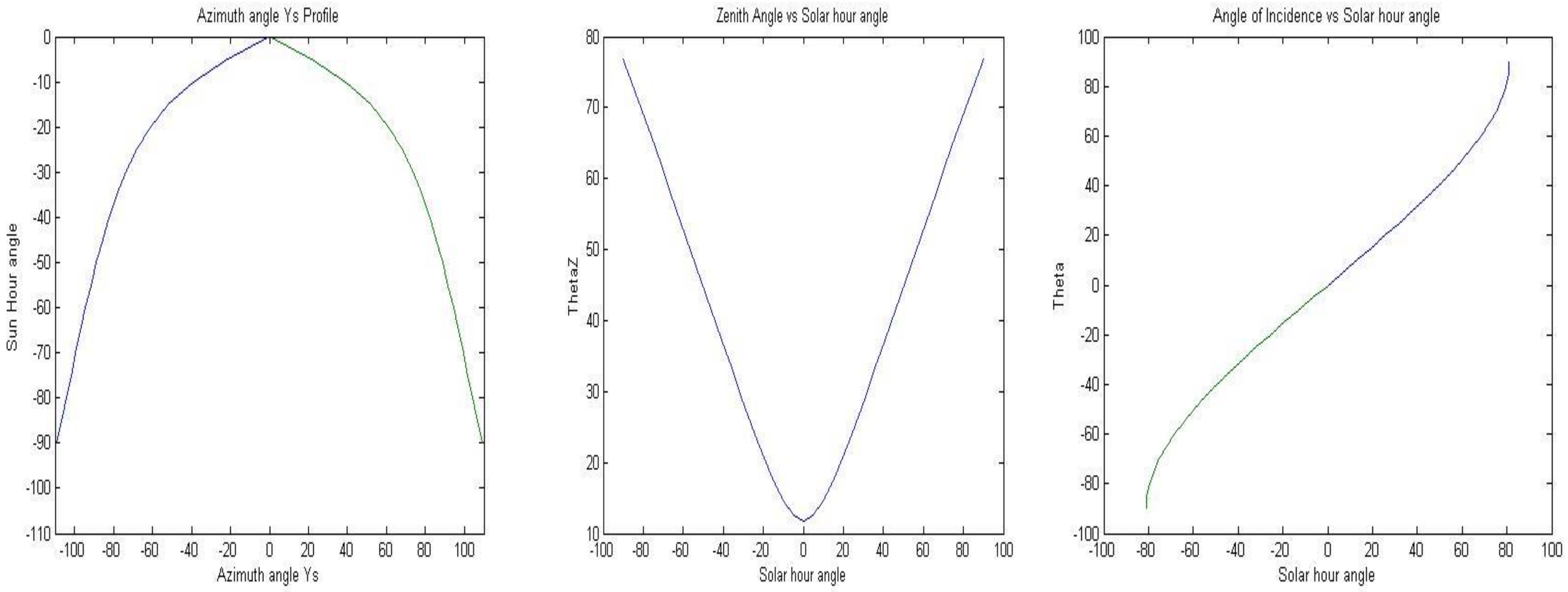
- Assumptions
  - Flagstaff at latitude of 35 degrees North
  - Fixed slope angle of 36 degrees
- Matlab Program
  - Based on desired day of the year
  - $\theta$ (angle of incidence)
  - $\gamma_s$ (Azimuth angle)
  - $\theta_z$ (Zenith angle)

North-South Axis slope tracking



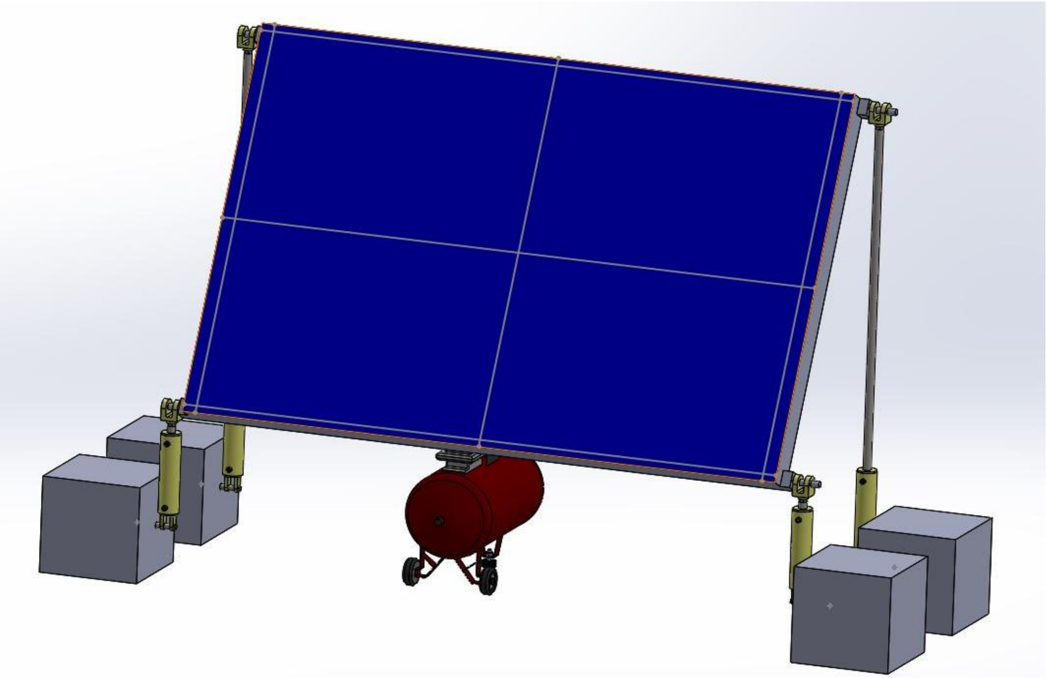

http://capsis.cirad.fr/capsis/help_en/samsaralight J

# Solar tracking Data

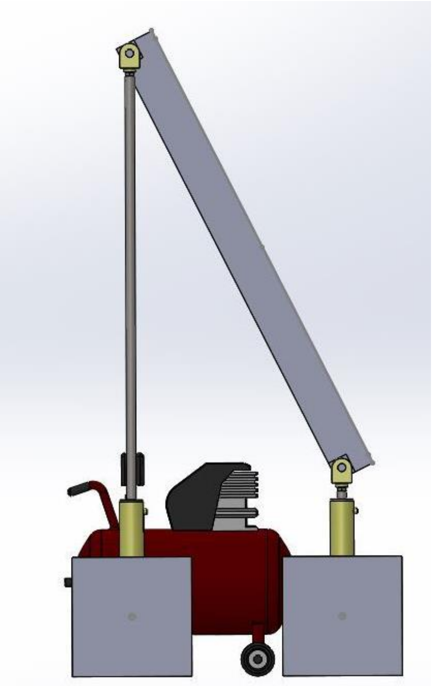


# Hydraulic Tracker Design

Isometric view



Side view

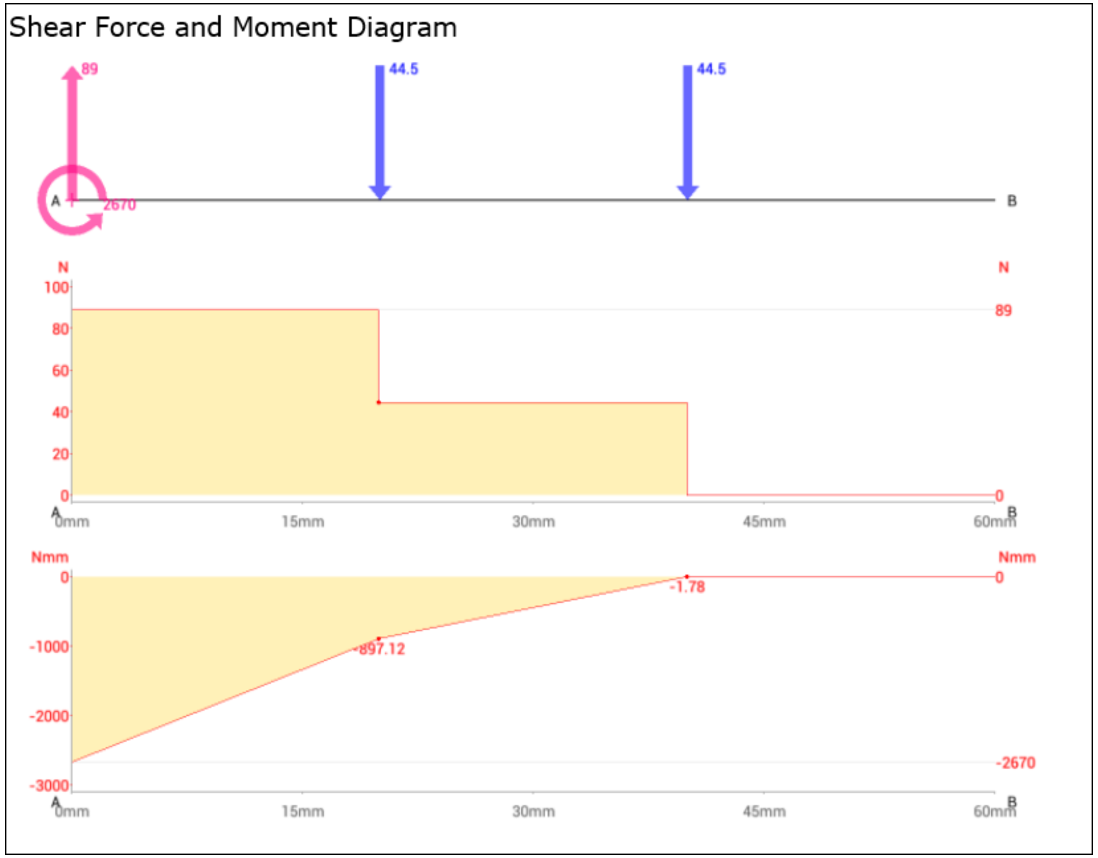


# Changes from original design

- MR fluid
  - Used in damper hydraulic
  - Does not produce a force
- No ball joint
  - No mass produced ball joint with needed dimensions
  - The panels weight can be held by the hydraulics

# Analysis

- The weakest point is the connection between the hydraulic and concrete blocks
- The force is 88.97 N
- Moment 2.67N-m

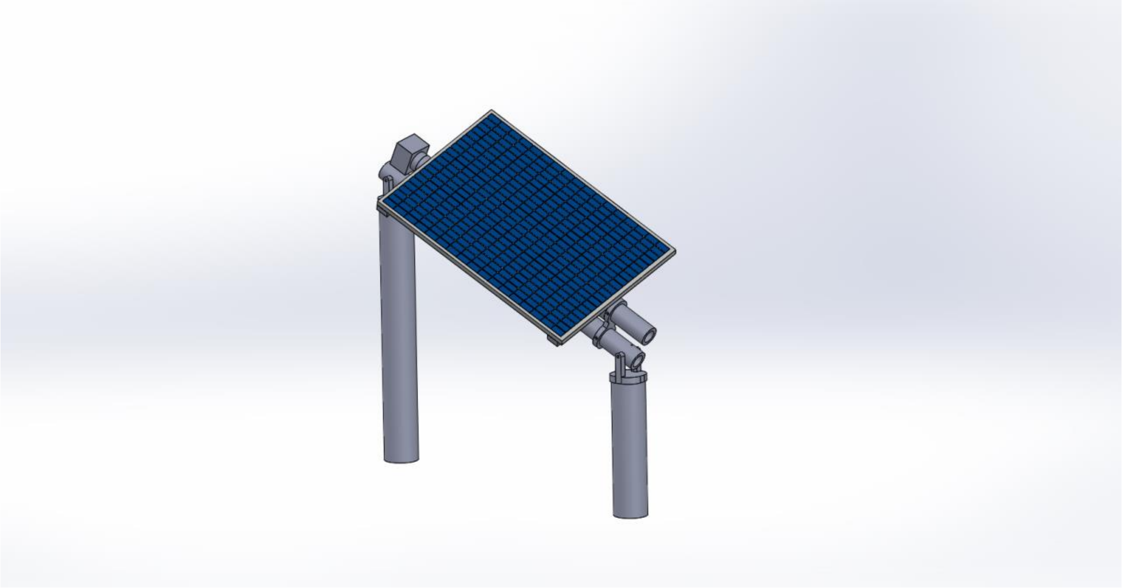


# Part Selection

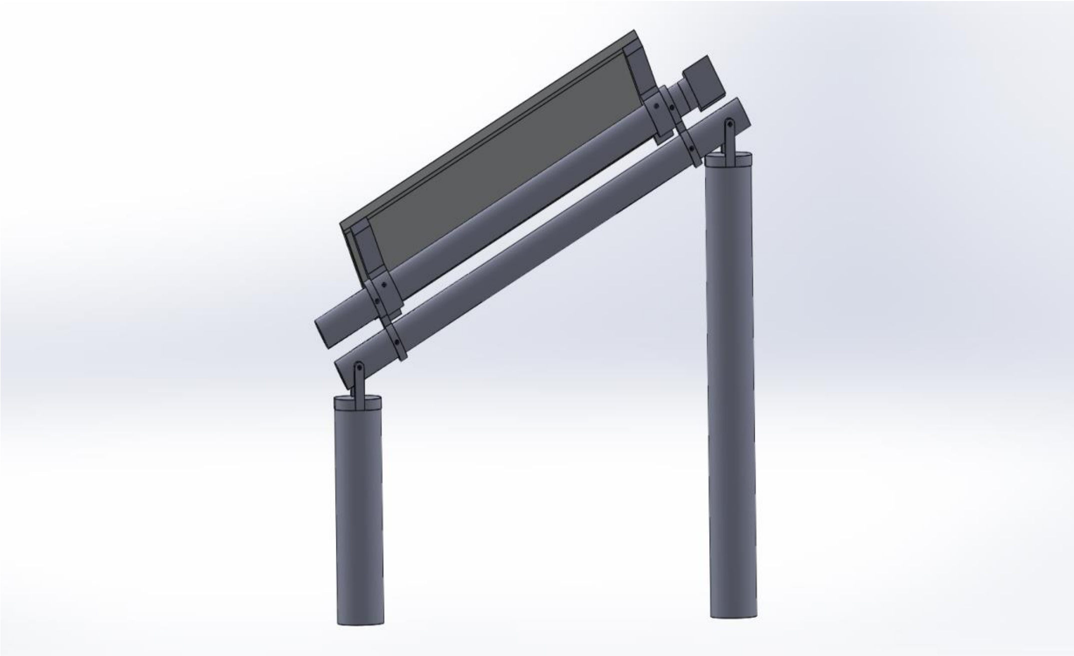
- Hydraulic
  - Piston diameter of 12.5 cm
  - Height difference is 1.045m
  - 49.1 kN of force
- Pump system
  - Produce 80 bars

# Angled Tracker Design

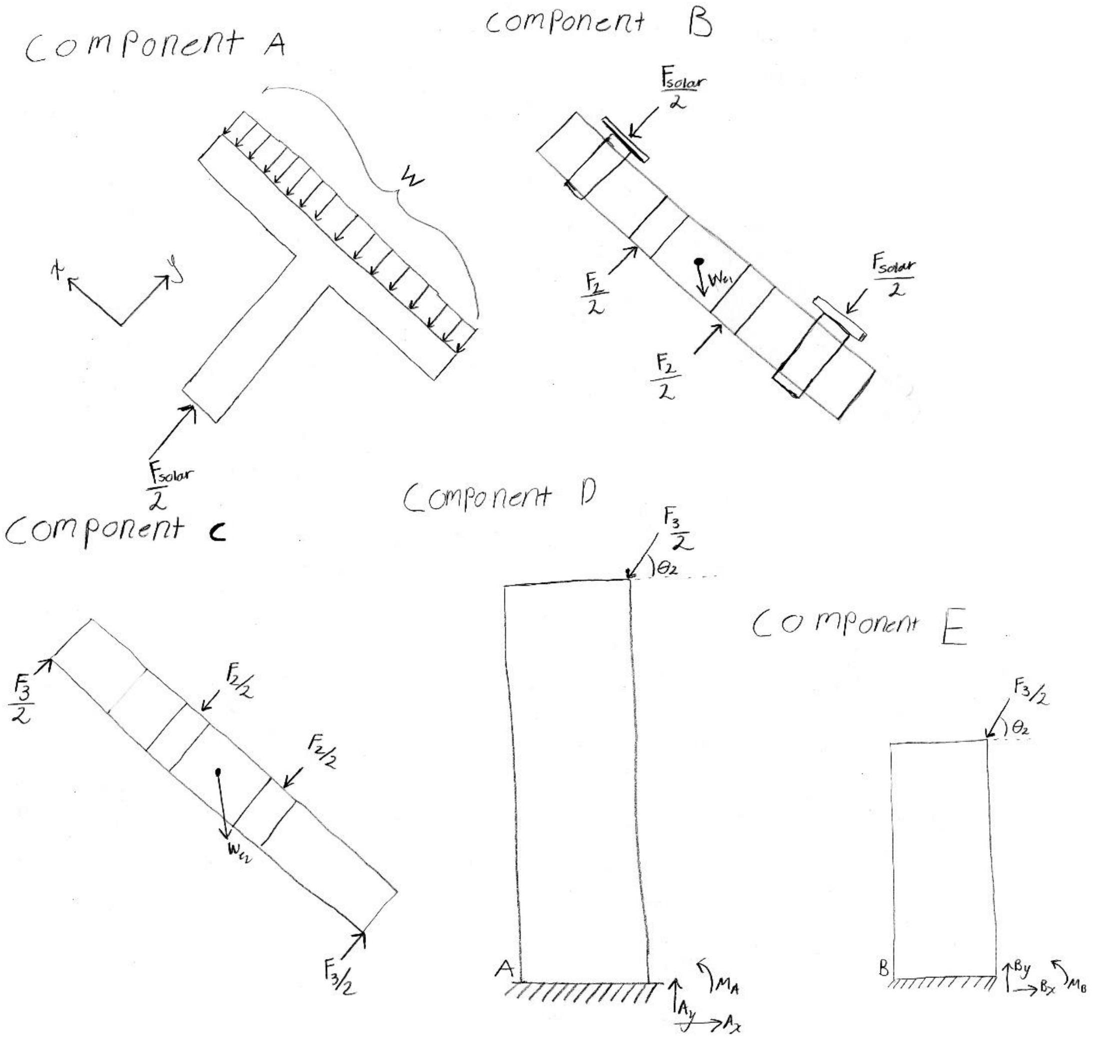
Isometric view



Side view



# Angled Solar Tracker Frame Analysis




**General Equations**

Component A

$\sum F_y = 0 = F_{solar} - F*W$
$\sum F_x = 0 = A_{1x}$

Component B & C

$\sum F_y = 0 = -F_{solar} + F_2 - W_{e1} * \sin(\theta_1)$
$\sum F_x = 0 = - W_{e1} * \cos(\theta_1)$

Component D & E

$\sum F_y = 0 = A_y - (F_3/2) * \sin(\theta_2)$
$\sum F_x = 0 = A_x - (F_3/2) * \cos(\theta_2)$
$\sum M_a = L * F_3/2 * \cos(\theta_2)$

Forces Solved

$F_{solar} = 325.4$ N

$F_2 = 341.42$ N

$F_3 = 357.44$ N

$A_y = 64.34$

$A_x = 166.737$

$B_y = 64.34$

$B_x = 166.737$

# Angled Solar Tracker Torque Analysis

- The Torque was calculated using :

$$T = (F \times 0.48) \times r$$

- Torque = 6.5079 N*m

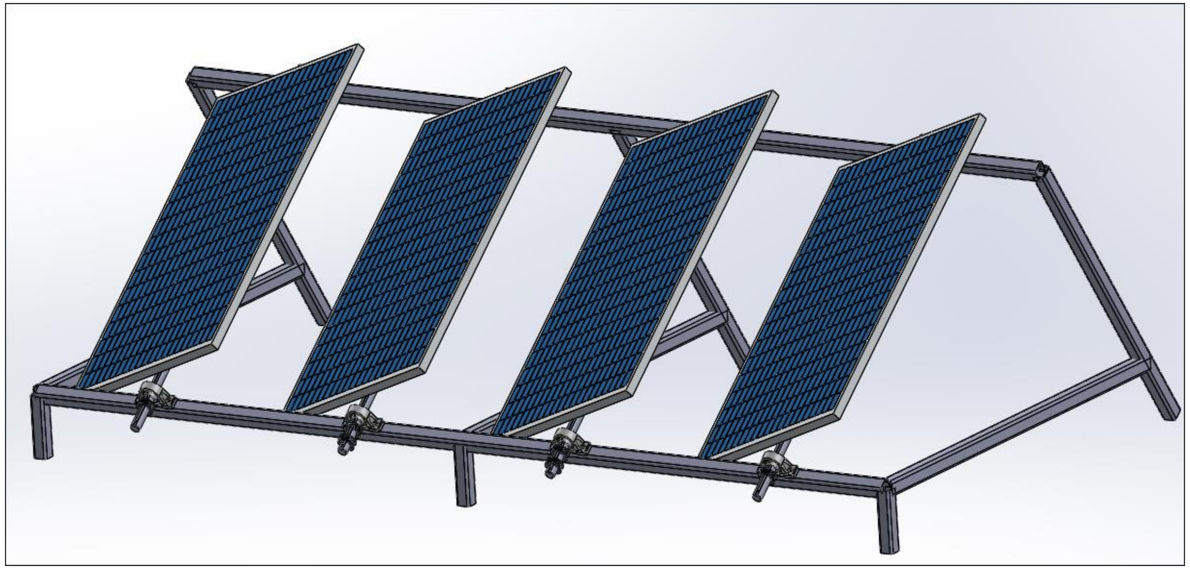
- Finding the desired Motor using Full-load Torque equation

$$T = (HP \times 5252)/rpm$$

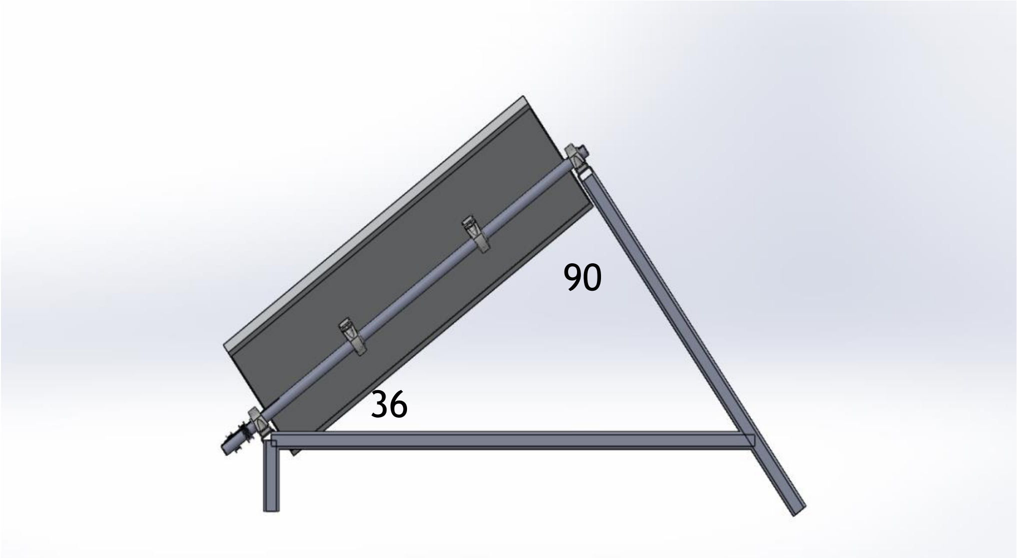
- HP/rpm = 0.001239

# Solar Panel Array

- 3”x3”x0.25” square hollow tube frame
- 2” diameter partially keyed drive shaft
- Mounted bearing
- Timing belt and pulley system
- Motor*
- Sensor and control system*

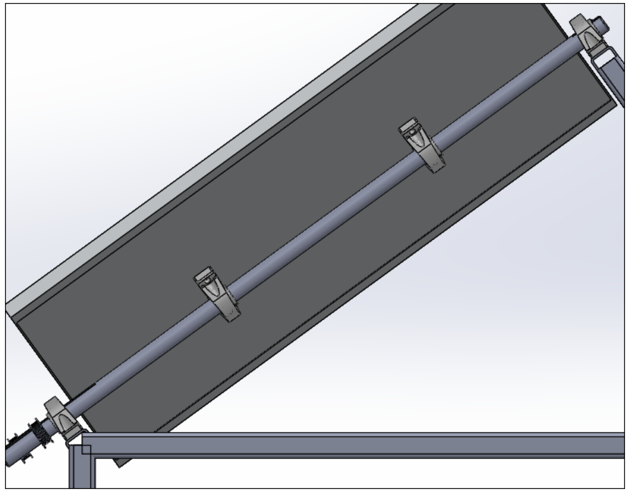


Isometric view

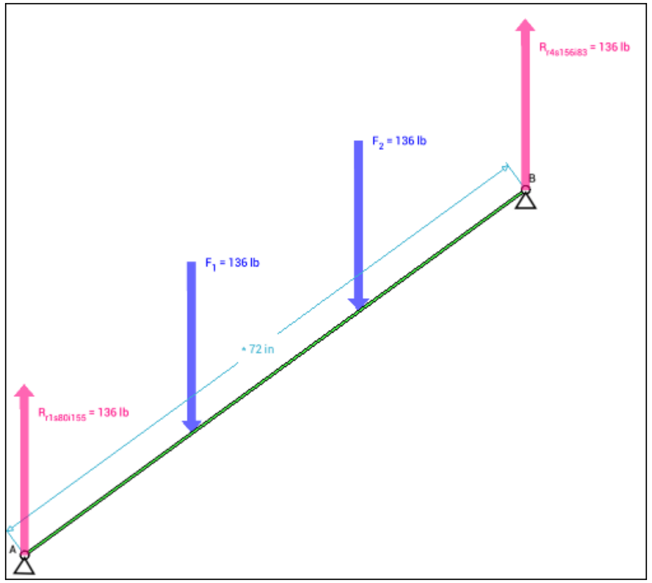



Side view

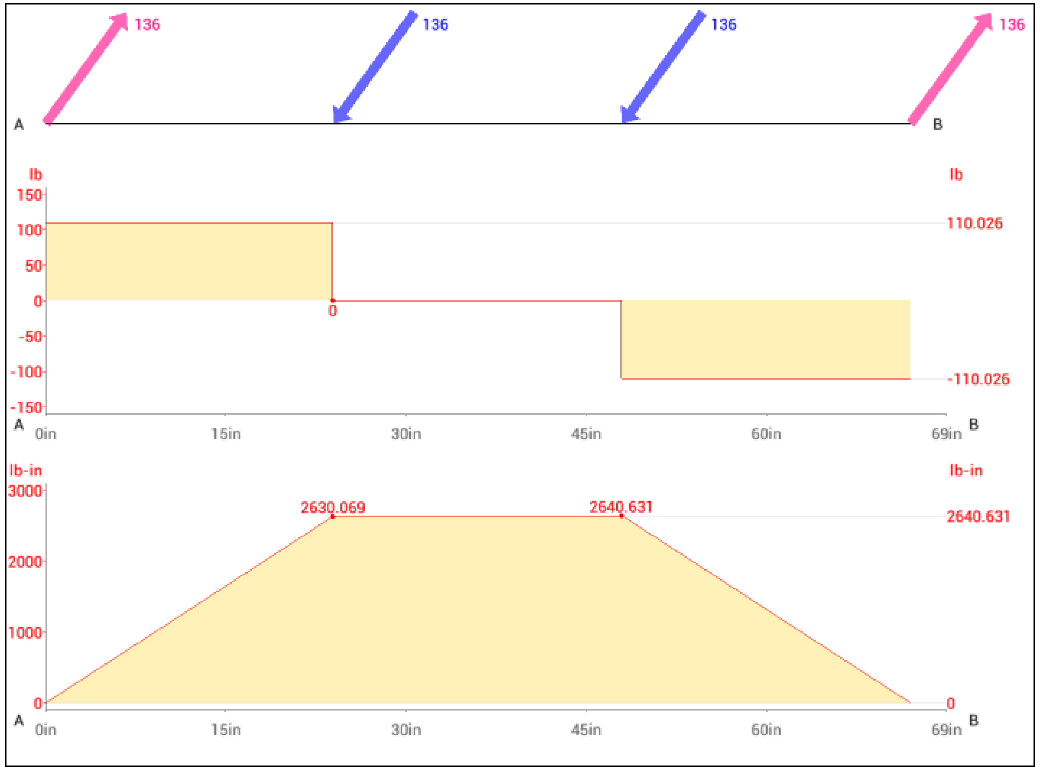
# Analysis of Solar Array Shaft



Side view of panels

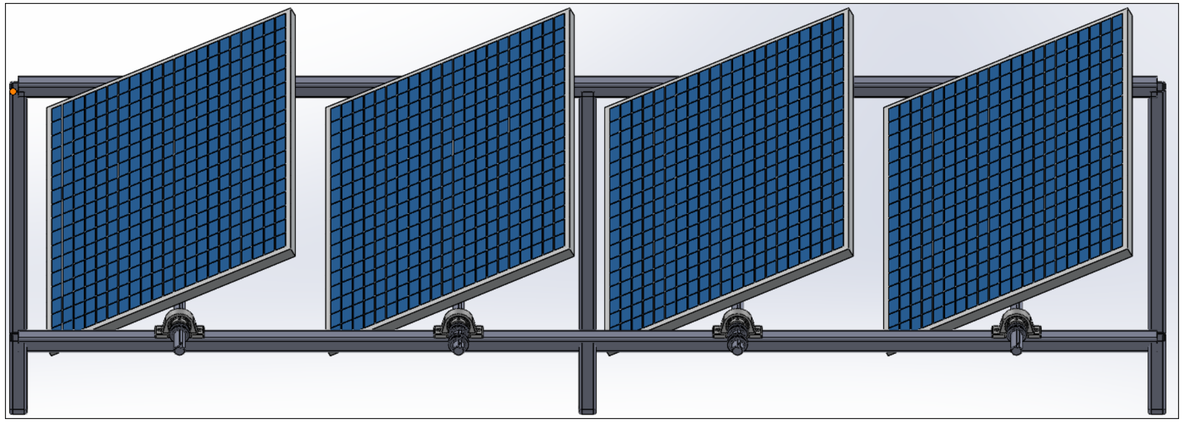


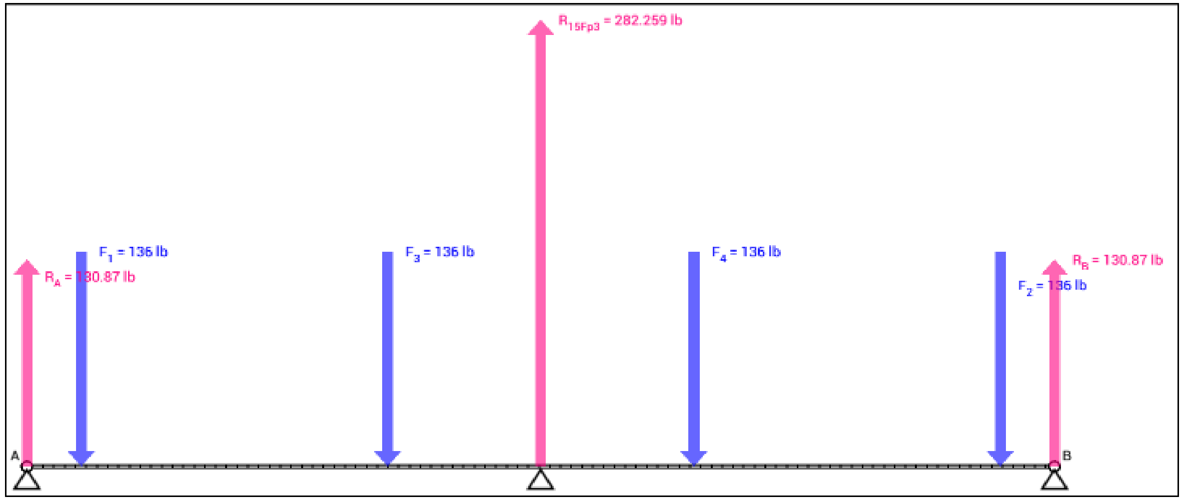

Shaft FBD



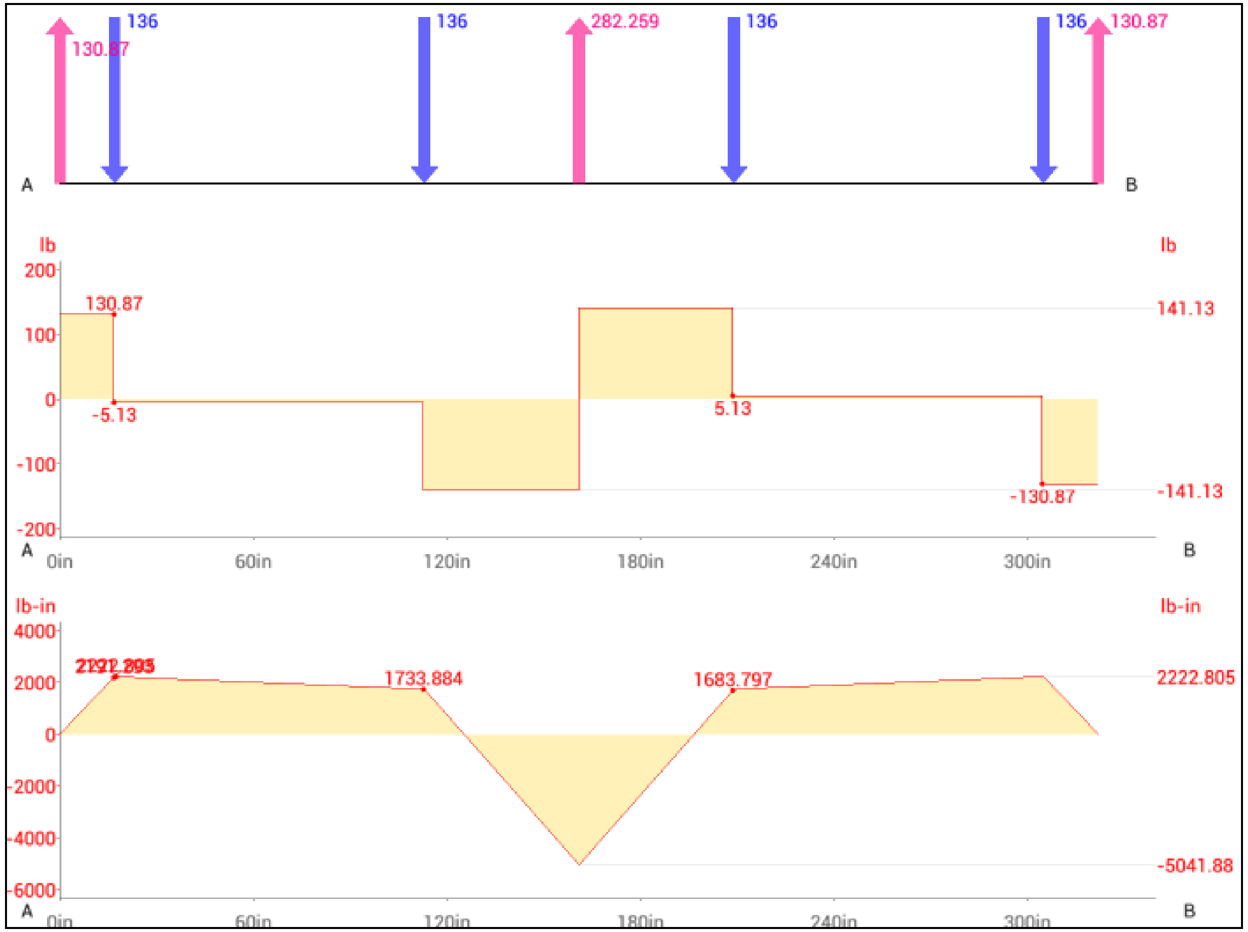

Moment Diagram Shaft

# Analysis of Solar Array Bottom






Bottom Frame FBD




Moment Diagram of bottom

# Solar Panel Array Torque Analysis

- The Torque was calculated using :

$$T = Fc \times r$$

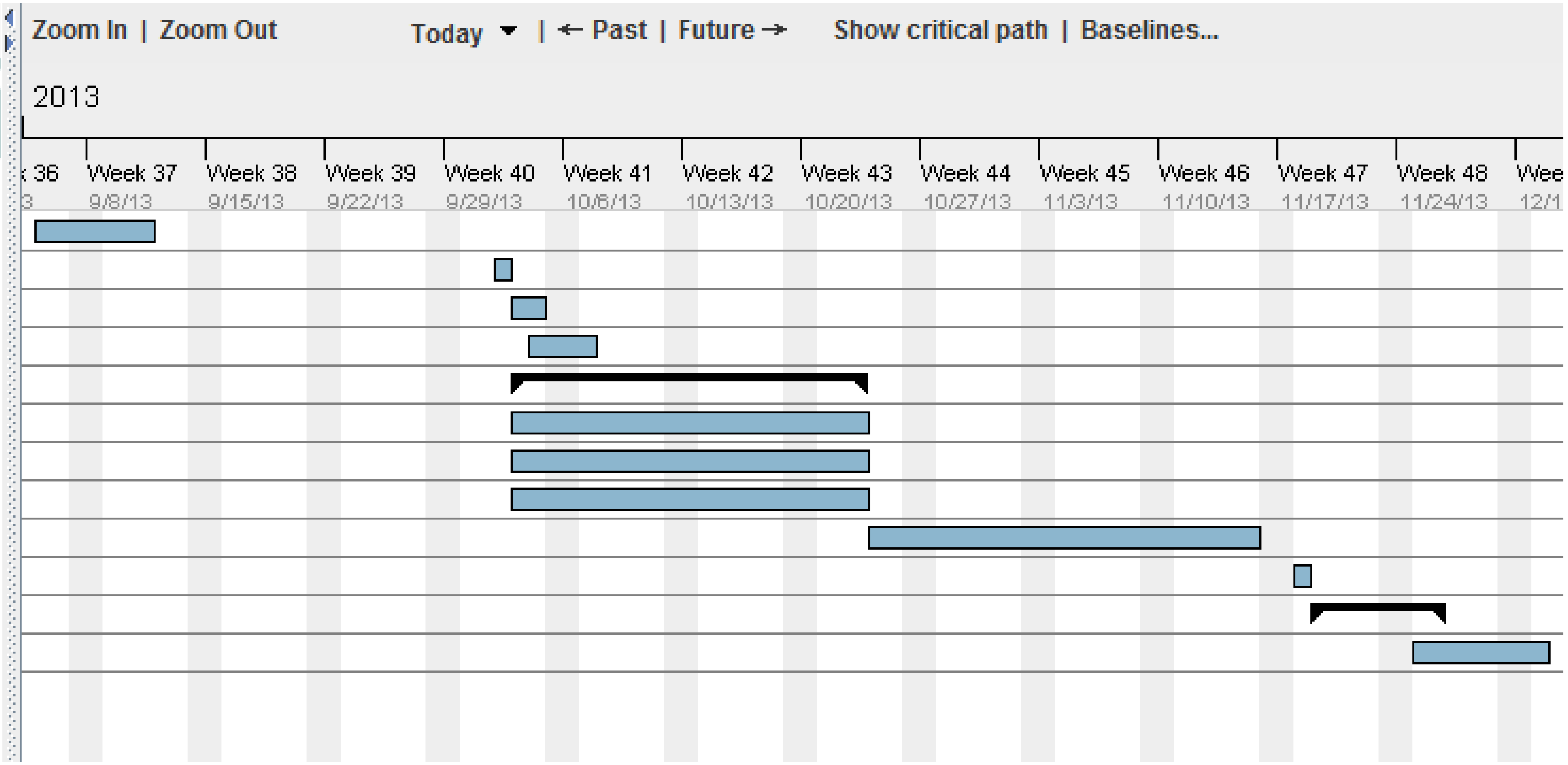
- Torque = 300 Ib-in
- Select the desired motor using equation

$$4T = (HP \times 5252 \times 8.851)/rpm$$

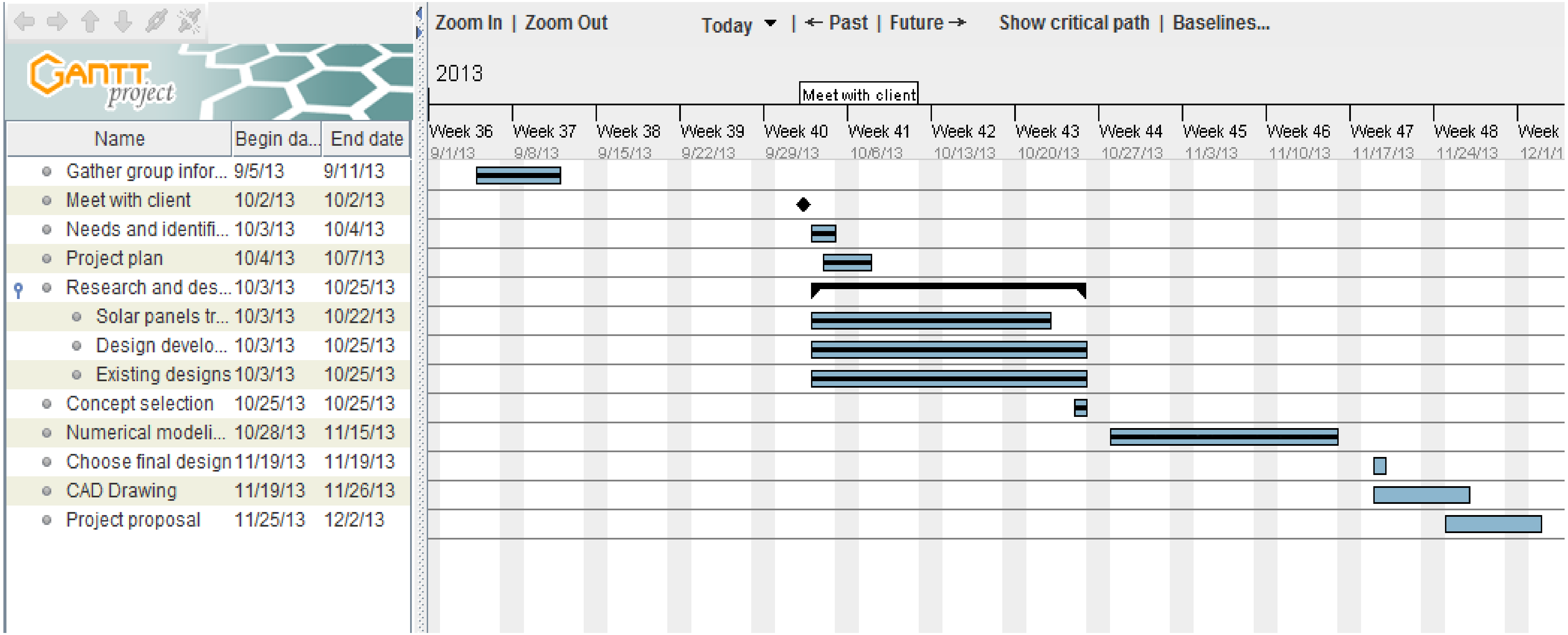
$$HP/rpm = 0.026$$

# Original Gantt Chart

| Name | Begin date | End date |
|---|---|---|
| Gather group information | 9/5/13 | 9/11/13 |
| Meet with client | 10/2/13 | 10/2/13 |
| Needs and identification | 10/3/13 | 10/4/13 |
| Project plan | 10/4/13 | 10/7/13 |
| Research | 10/3/13 | 10/23/13 |
| Solar panels | 10/3/13 | 10/23/13 |
| Design development | 10/3/13 | 10/23/13 |
| Existing designs | 10/3/13 | 10/23/13 |
| Numerical modeling | 10/24/13 | 11/15/13 |
| Choose final design | 11/18/13 | 11/18/13 |
| CAD drawing | 11/19/13 | 11/26/13 |
| Project proposal | 11/25/13 | 12/2/13 |



# Updated Gantt Chart



| Name | Begin da... | End date |
| --- | --- | --- |
| Gather group infor... | 9/5/13 | 9/11/13 |
| Meet with client | 10/2/13 | 10/2/13 |
| Needs and identifi... | 10/3/13 | 10/4/13 |
| Project plan | 10/4/13 | 10/7/13 |
| Research and des... | 10/3/13 | 10/25/13 |
| Solar panels tr... | 10/3/13 | 10/22/13 |
| Design develo... | 10/3/13 | 10/25/13 |
| Existing designs | 10/3/13 | 10/25/13 |
| Concept selection | 10/25/13 | 10/25/13 |
| Numerical modeli... | 10/28/13 | 11/15/13 |
| Choose final design | 11/19/13 | 11/19/13 |
| CAD Drawing | 11/19/13 | 11/26/13 |
| Project proposal | 11/25/13 | 12/2/13 |

# Conclusion

- We went over the analysis of the solar tracking angles that our systems will use.
- Presented updated designs in SolidWorks.
- Structural analysis for each design.
- As well as going over our progress in our Gantt chart

# References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2. Budynas G., Richard, Nisbett J., Keith, 2011, “Shigley’s Mechanical Engineering Design”, Ninth Edition, McGraw-Hill, New York, New York
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# Questions?