

# Solar Tracking Structure Design

## Concept Generation and Selection

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Jiayang 1

# Presentation Outline

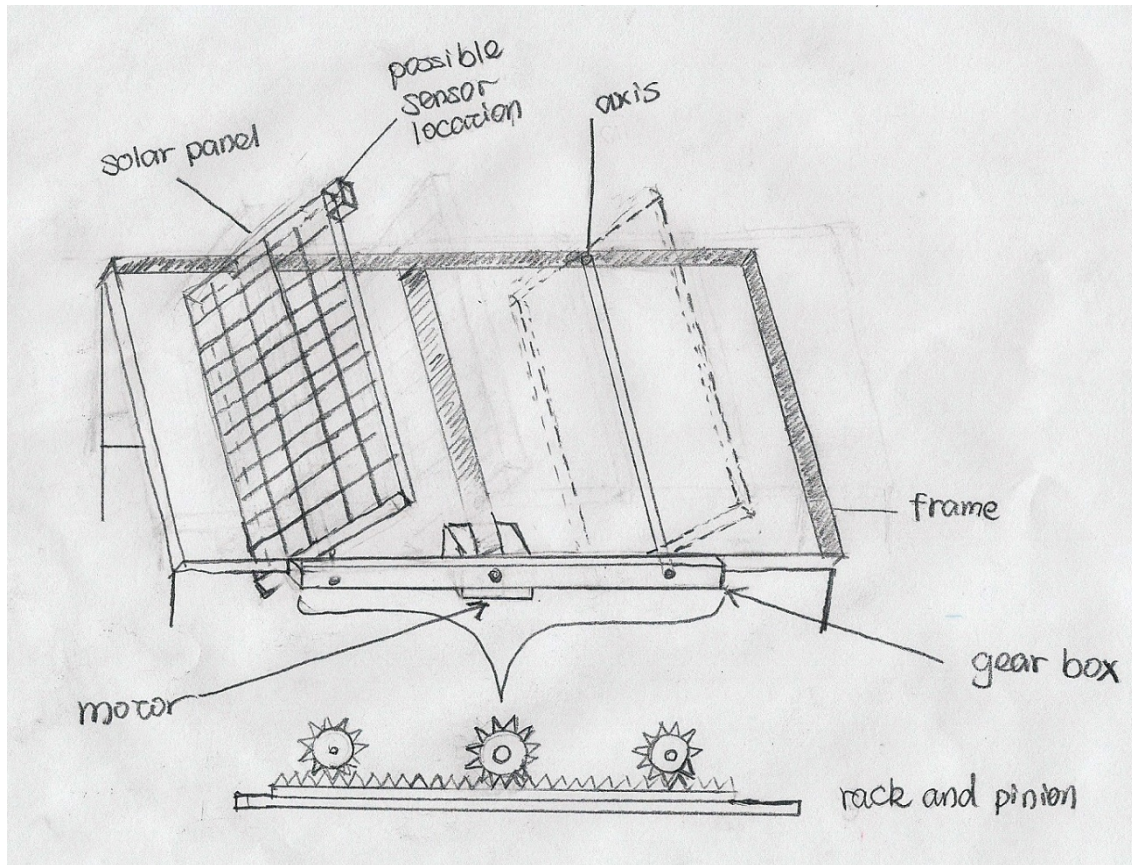
- Project introduction
- Concept generation
- Concept selection
- Updated project plan
- Conclusion

# Project Introduction

- **Need**  
Current solar tracking systems are expensive unreliable and hard to maintain.
- **Objective**  
Design a light-weight yet reliable solar tracking technology.
- **Sponsor**  
Dr. Tom Acker
- **Testing environment**  
Will be tested with existing fixed solar panels

# Solar Panel Array

Rack and pinion system with multiple panels



Advantages:

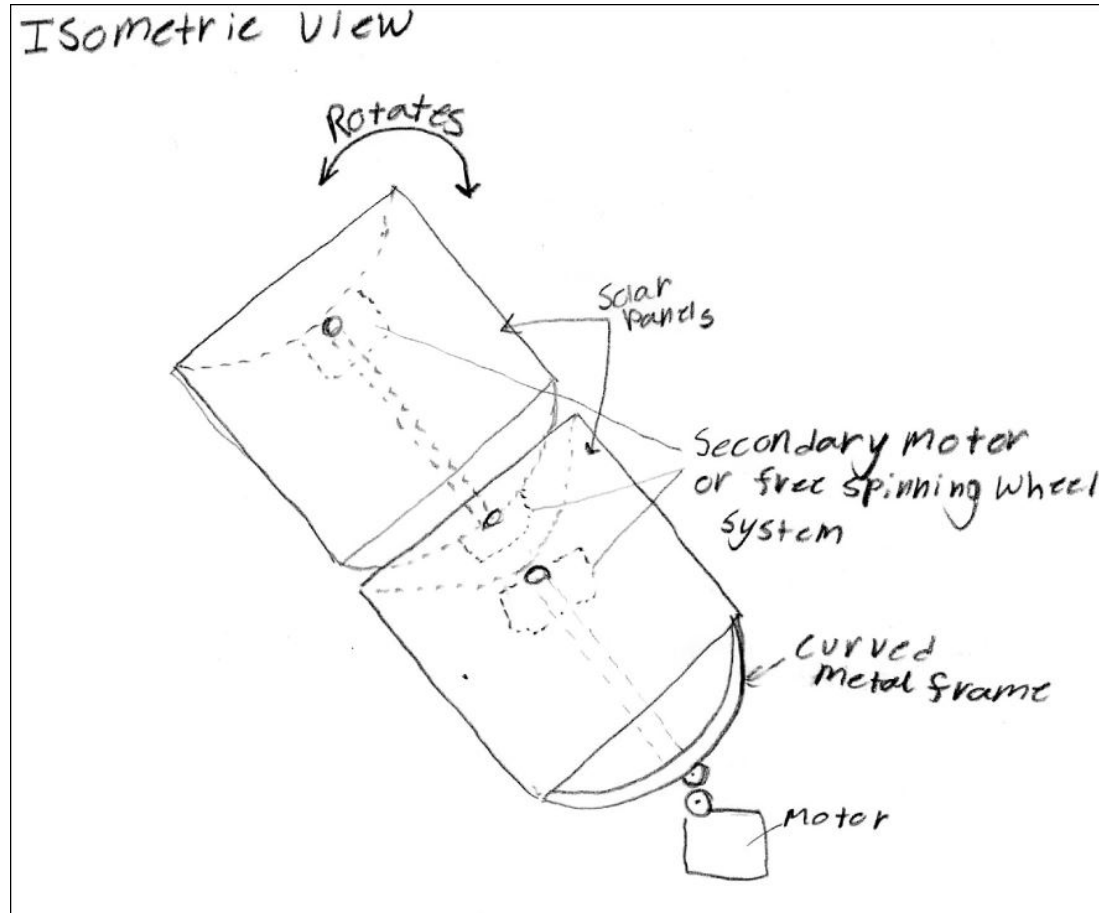
- Low cost
- Simplicity
- High reliability

Disadvantages:

- One degree of freedom
- Large torque needed
- Large working space

# Half-Cylinder Design

Isometric view of half cylinder design



## Advantages:

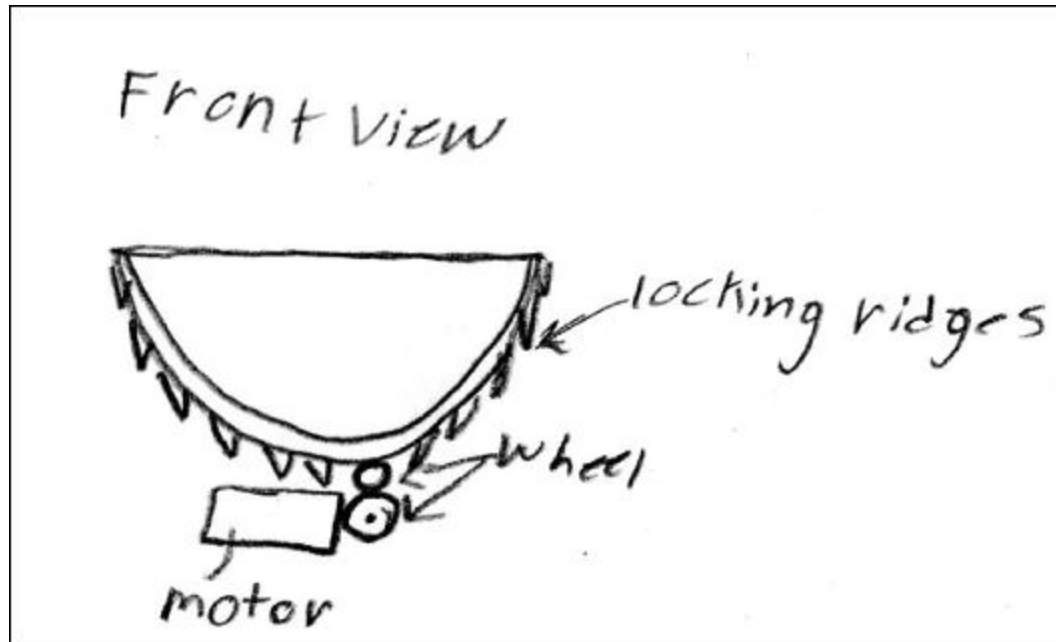
- Unique look
- Can have multiple panels

## Disadvantages:

- Difficult to manufacture
- Requires a powerful motor
- Costly specialized wheel

# Half-Cylinder Design Continued

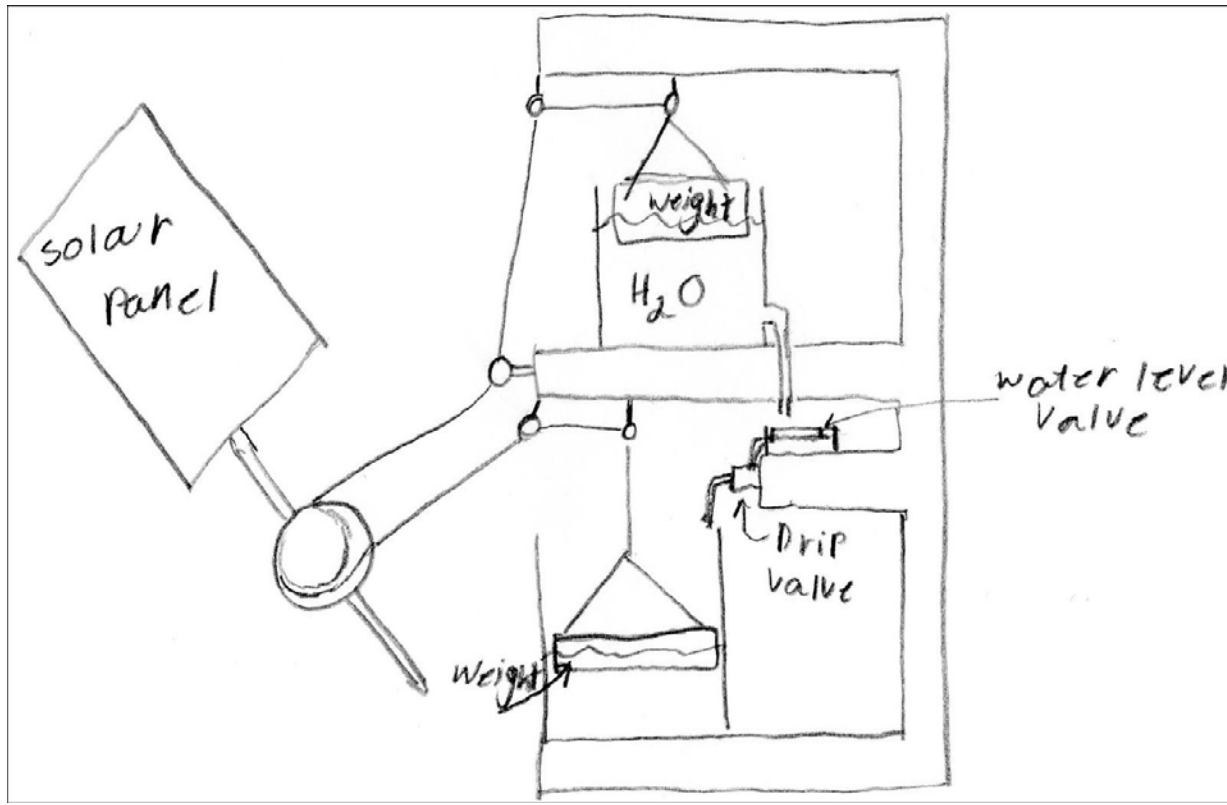
Front view of half gear cylinder



- Allows for multiple panels to track the sun east to west.
- Can be powered by one motor or multiple
- Half circle frame has groves to hold the solar panel in place

# Low Tech Water tracking system

Diagram of water tracking system



## Advantages:

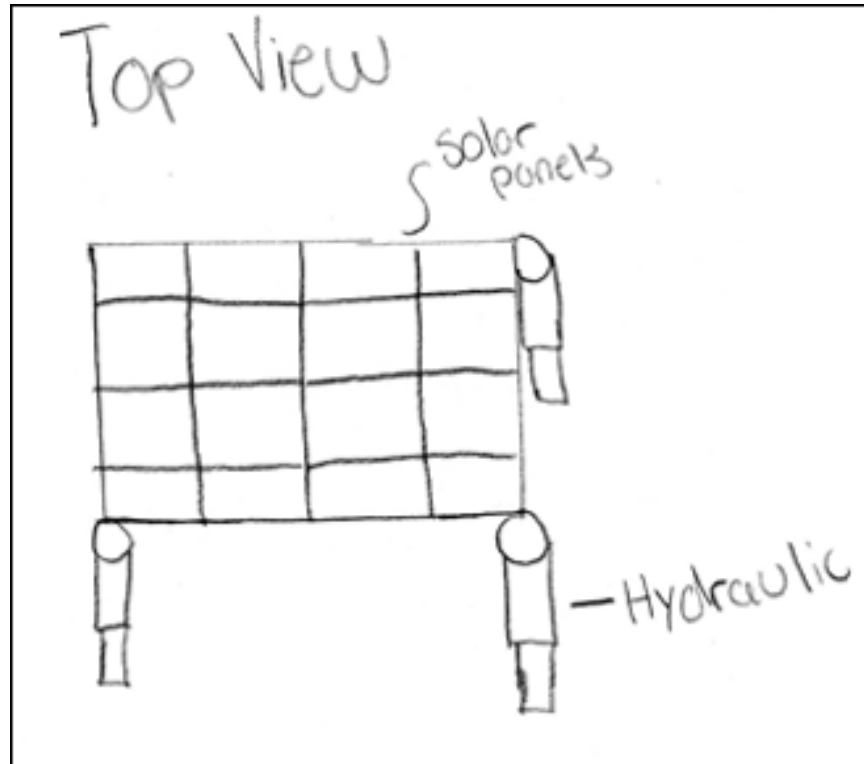
- Does not require power
- Can be easily modified to use power
- Innovative

## Disadvantages:

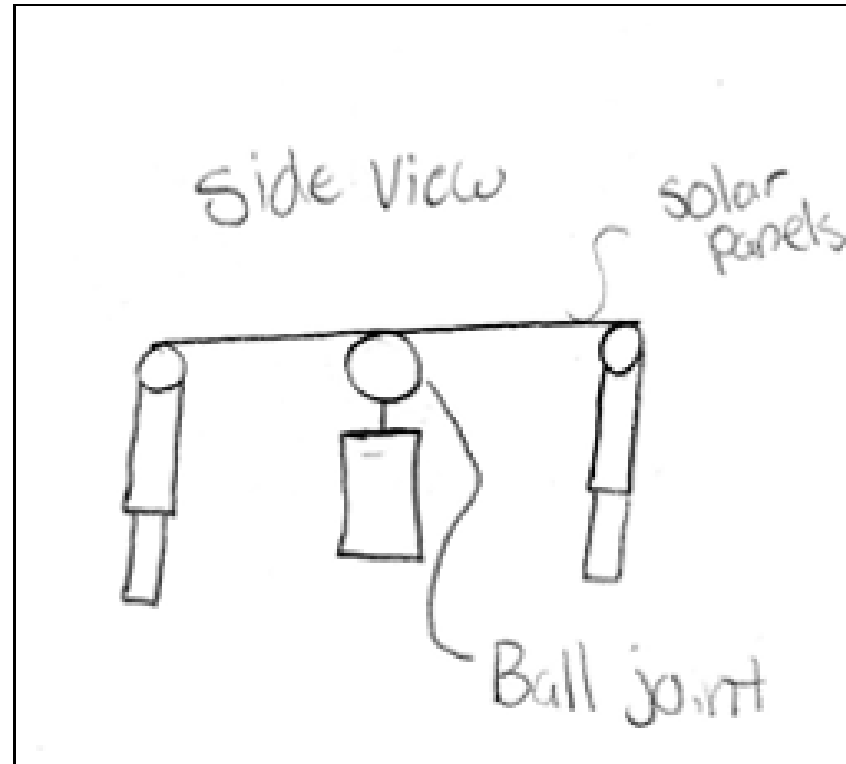
- Requires constant maintenance
- Weather dependent
- Only works for one solar panel

# Hydraulic Ball Joint

The top side of system



Side view of system with ball joint





# Hydraulic Ball Joint continued

## Advantages:

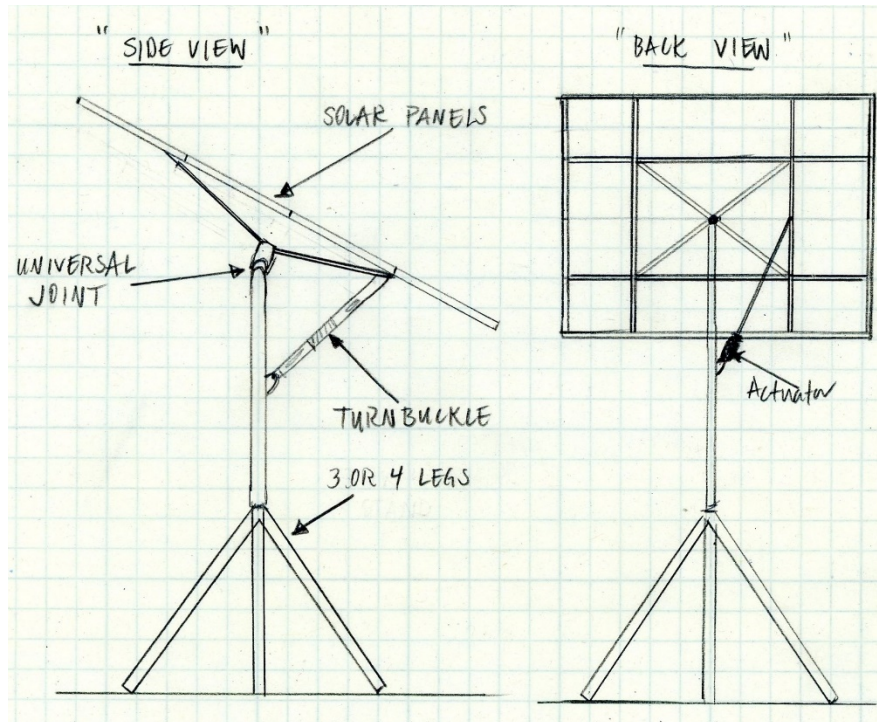
- No gears or motor needed
- Could use either passive or active components

## Disadvantages:

- Need a huge ball and joint support.
- The uses of smart materials can be costly
- Is untested

# Standing Tripod Design

Simple tripod that is easy to move



- Elevated design
- Tray-like design holding all 4 panels
- Turnbuckle for north-south setting
- Actuator for east-west setting

# Advantages vs. Disadvantages

- Advantages

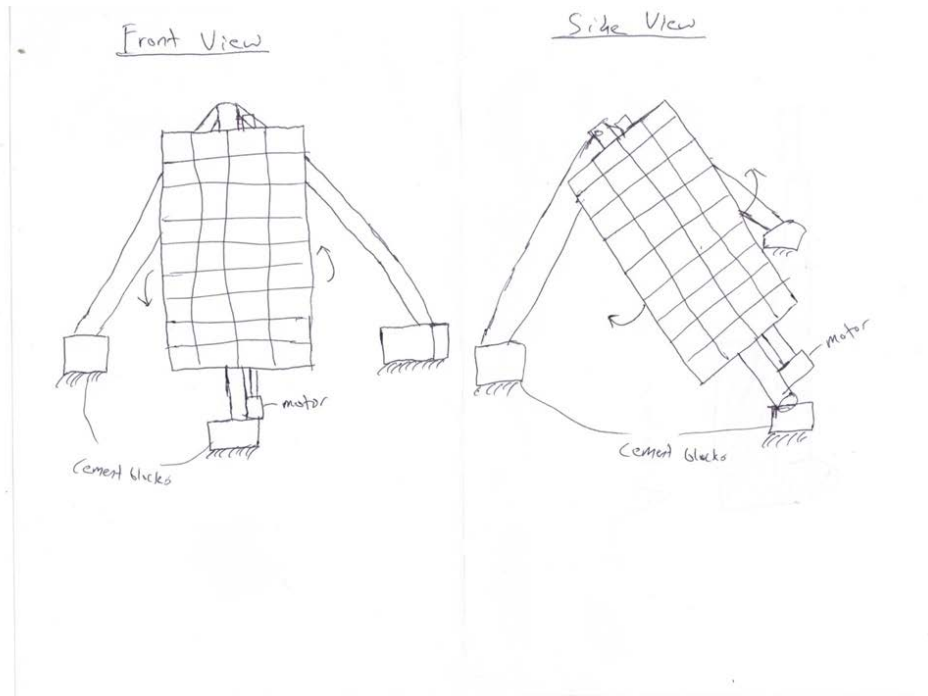
- Inexpensive
- North-south and east-west movement
- Parts readily available
- Portable

- Disadvantages

- Needs external power source
- Unsafe due to elevated design
- Cannot withstand inclement weather
- Manual operation for north-south setting

# Angled Solar Tracker

Simple tripod design that is angled



## Advantages

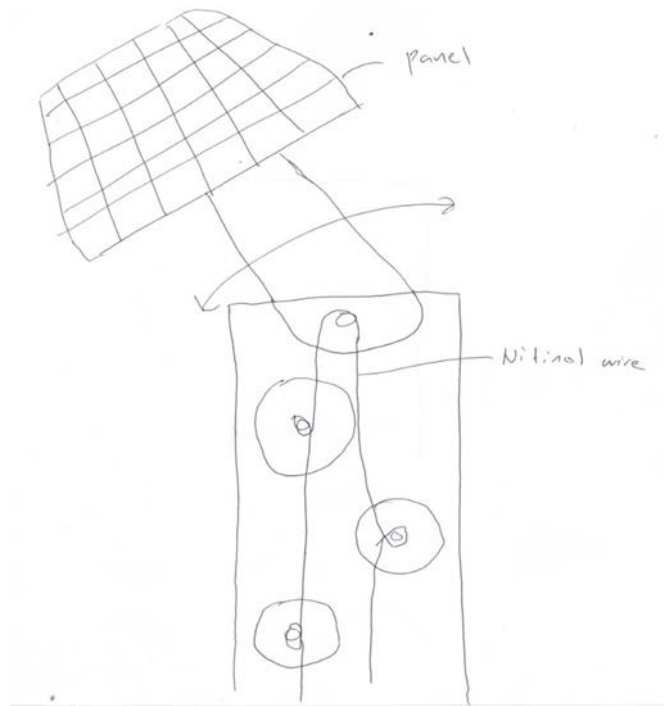
- Done before
- Simple design
- Low cost
- Active or passive

## Disadvantages

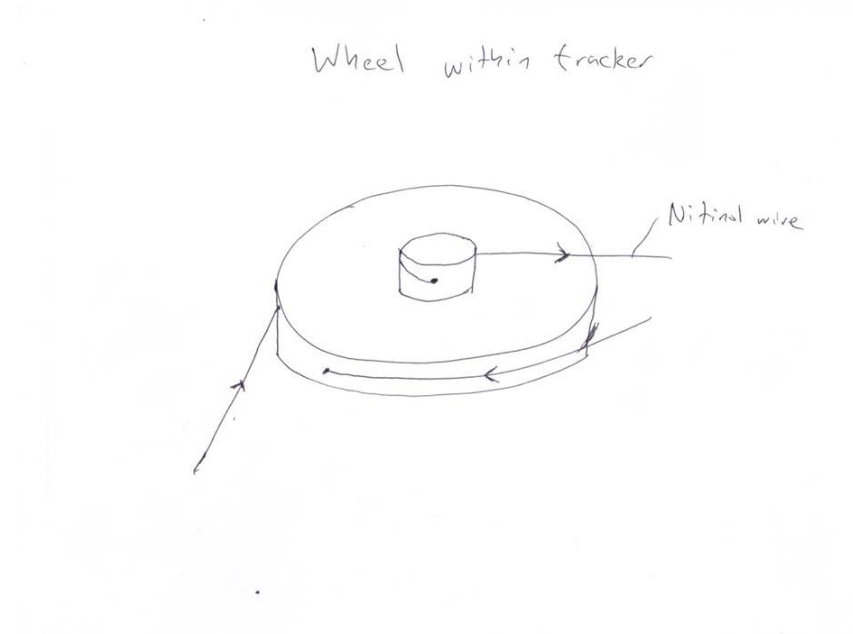
- Not marketable
- Only one solar panel
- Space may be a problem

# Nitinol Solar Tracker

Side view of system with wheels



Close up view of the wheel



# Nitinol Tracker Continued

## Advantages

- Simple design
- Marketable
- Could be used for multiple panels
- Saves space

## Disadvantages

- Design has not been tested
- Large amount of Nitinol required
- Price will be high
- Unknown energy requirements
- Lots of unknowns

# Concept selection categories

1. Reliability
  - Consistency
  - How often does it break down?
2. Survivability
  - Will it operate effectively in Flagstaff?
3. Maintenance
  - How hard is it to fix?
4. Safety
  - Design present danger to people?
5. Efficiency
  - How much energy does it generate?
6. Cost
  - Price of the design
7. Light weight
  - Easy to move or install

# Category Weight

Weight is from 1 to 7, 1 being the least important 7 being the most important

Lightweight=1

- Self-imposed
- Not harmful or beneficial

Survivability=2

- Designed for all weather
- Broken solar panel doesn't collect energy

Maintenance=3

- high maintenance < efficiency, reliability, cost
- Client wants a maintainable system

Safety=4

- Always important
- Unsafe design could short circuit, fall apart during maintenance, etc.

Efficiency=5

- Current designs inefficient
- More efficient than current setup

Cost=6

- Current designs are expensive

Reliability=7

- Current systems break down often
- Dr. Acker emphasized this objective
- Consistent energy production



# Concept Decision Matrix

## Concept selection matrix

	<u>Safety</u>	<u>Cost</u>	<u>Light weight</u>	<u>Efficiency</u>	<u>Maintenance</u>	<u>Reliability</u>	<u>Survivability</u>	
<u>Weighted Importance</u>	4	6	1	5	3	7	2	<u>Total</u>
<u>Designs</u>								
Half Cylinder	0	-1	-1	1	0	0	1	0
angled tracker	1	1	0	1	1	1	1	27
Solar array	1	1	0	1	0	1	1	24
ball joint	1	0	1	1	1	1	1	22
nitinol tracker	1	-1	1	0	1	1	1	11
Water low tech	0	1	-1	0	-1	0	1	4
Standing tripod	0	1	1	1	1	1	0	22

# Passive and Active Matrix

## Passive

- Pros
  - Does not use electricity
- Cons
  - Less precise
  - Less sturdy

## Active

- Pros
  - Accurate
  - More structurally sound
- Cons
  - Uses power produced by the solar panels

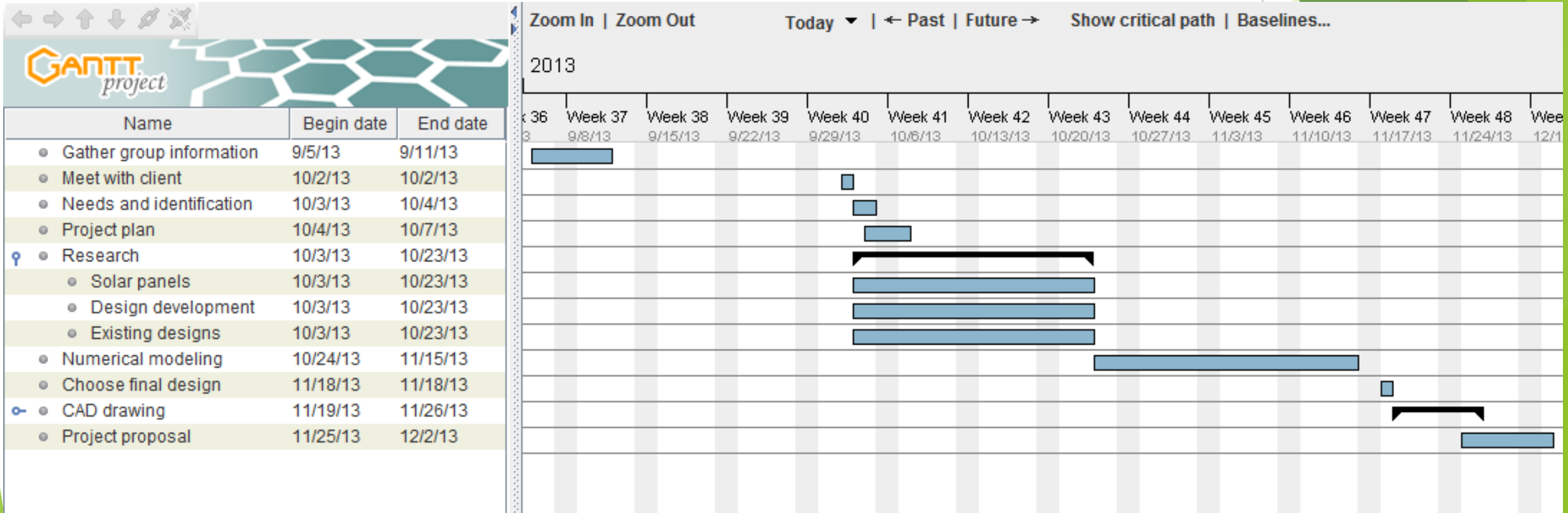
# Passive vs. Active decision matrix

Passive vs. active matrix

	<u>Cost</u>	<u>Efficency</u>	<u>Reliable</u>	
<u>Weighted Importance</u>	1	3	2	<u>Total</u>
<u>Tracking systems</u>				
Active	-1	1	1	4
Passive	0	0	1	2

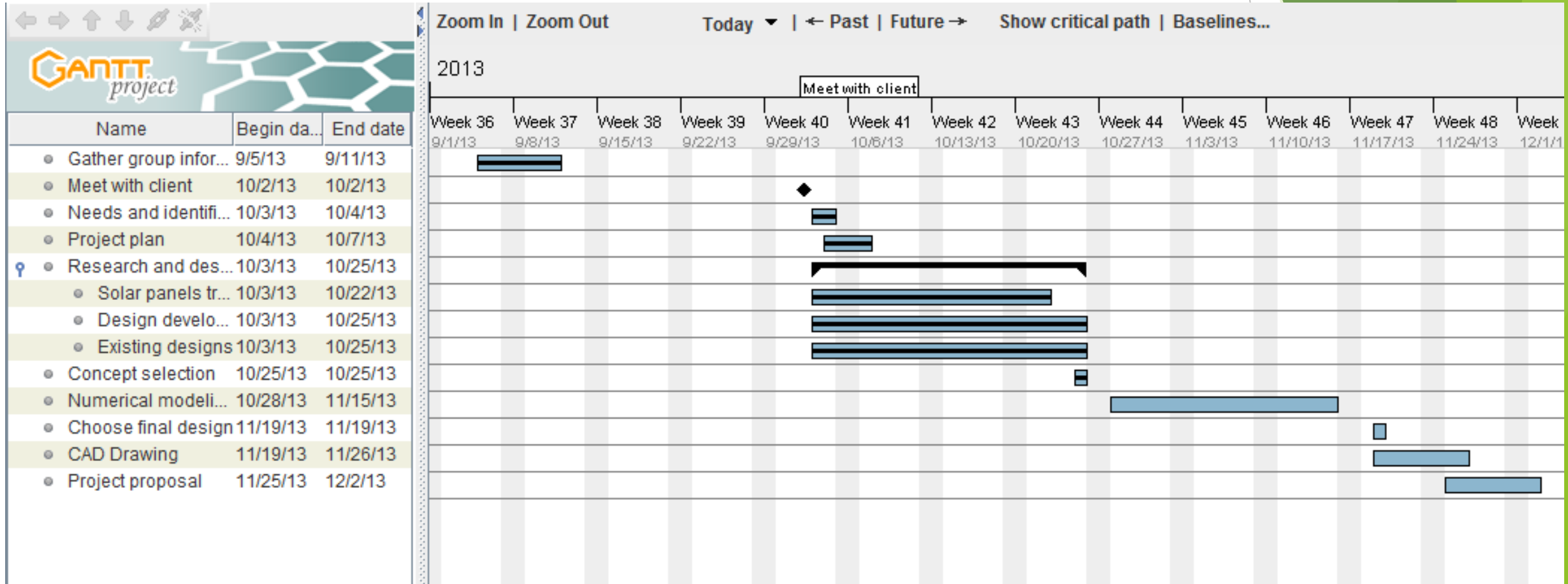
# Original Gantt Chart

Old



# Updated Gantt Chart

New



# Conclusion

- Two main tracking methods can be applied for designing solar tracking structure
  - passive methods
  - active methods
- 7 different design concepts which were introduced
- The candidate for the design concept were chosen based on the decision matrix

# References

1. Budynas G., Richard, Nisbett J., Keith, 2011, "Shigley's Mechanical Engineering Design", Ninth Edition, McGraw-Hill, New York, New York
2. Leo J., Donald, 2007, "Engineering Analysis of Smart Material Systems", John Wiley & Sons, Inc., Hoboken, New Jersey.
3. (2008). " PVWATTS: Arizona - Flagstaff." PVWATTS Calculator <<http://rredc.nrel.gov/solar/calculators/PVWATTS/version1/US/code/pvwattsv1.cgi> >(Oct. 26, 2013)

# Questions?