# Active Roof System

## Problem Formulation and Project Plan

**Mohammed Alkhaldi , Coy Cody, Donovan Hard, Marissa Munson, and Krysten Whearley**

October 7th, 2013

# Overview

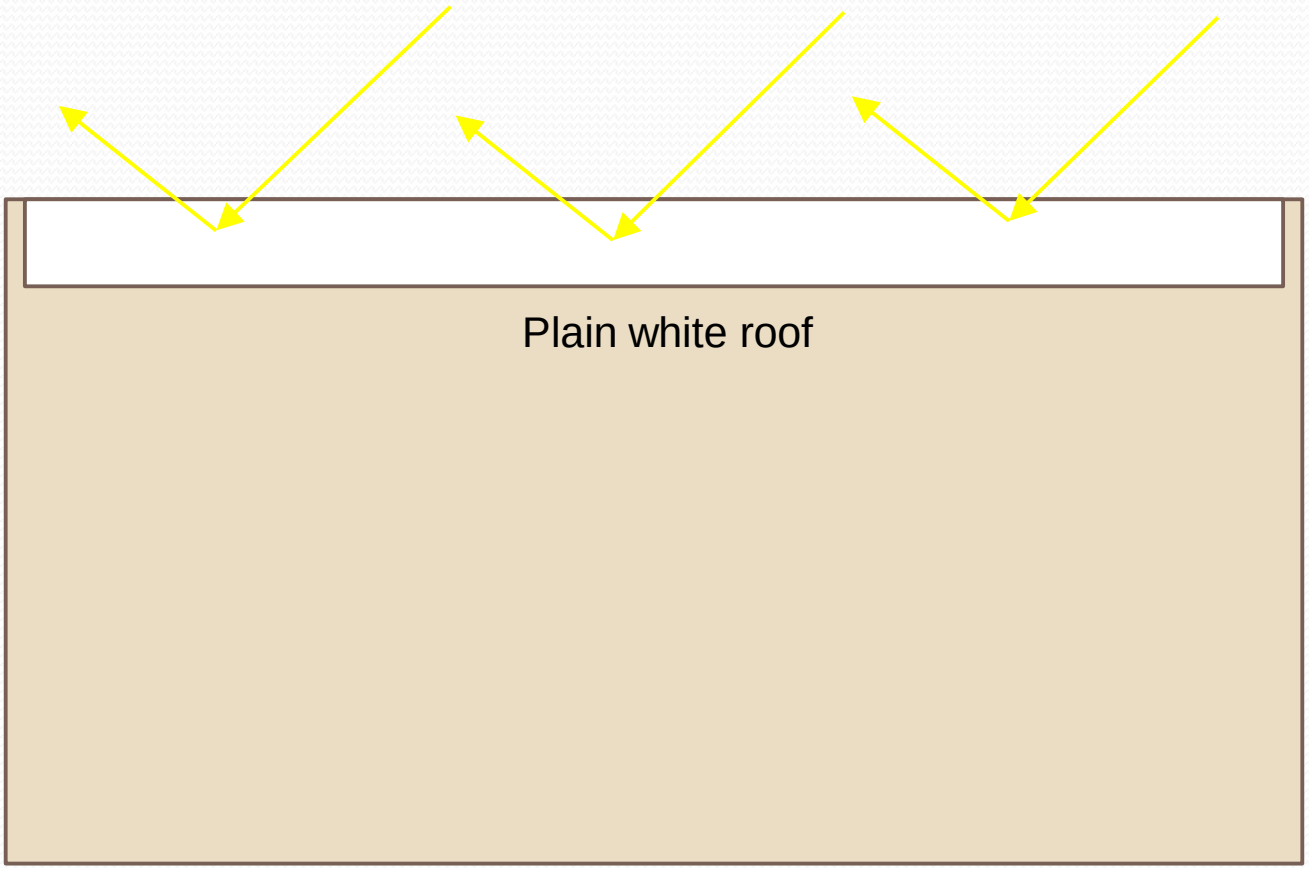
- Project Introduction
- Brief Descriptions of Roof Systems
- Need Statement & Project Goal
- Operating Conditions
- Constraints
- Engineering Requirements
- Quality Function Deployment (QFD)
- Basic Timeline
- Conclusion

# Project Introduction

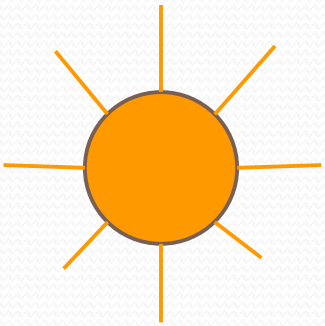
- Amount of power consumption due to cooling and heating of large warehouse buildings it too high
  - Project will investigate roof designs that will lower this power consumption

- Project Clients
  - Dr. Michael Shafer (NAU Professor)

# Control System

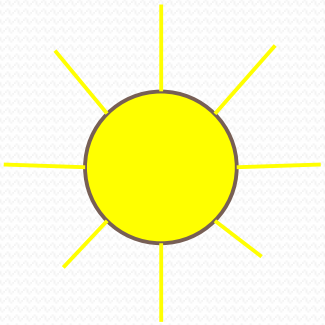


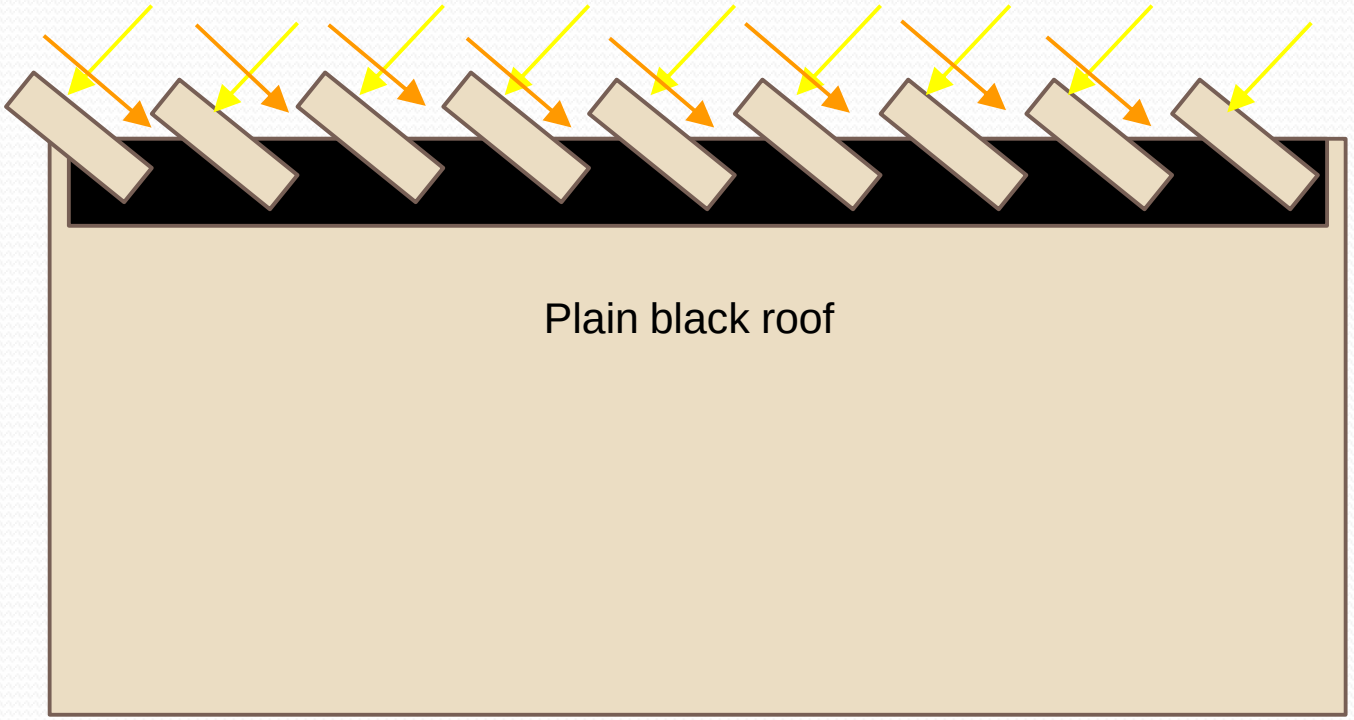
# Passive System



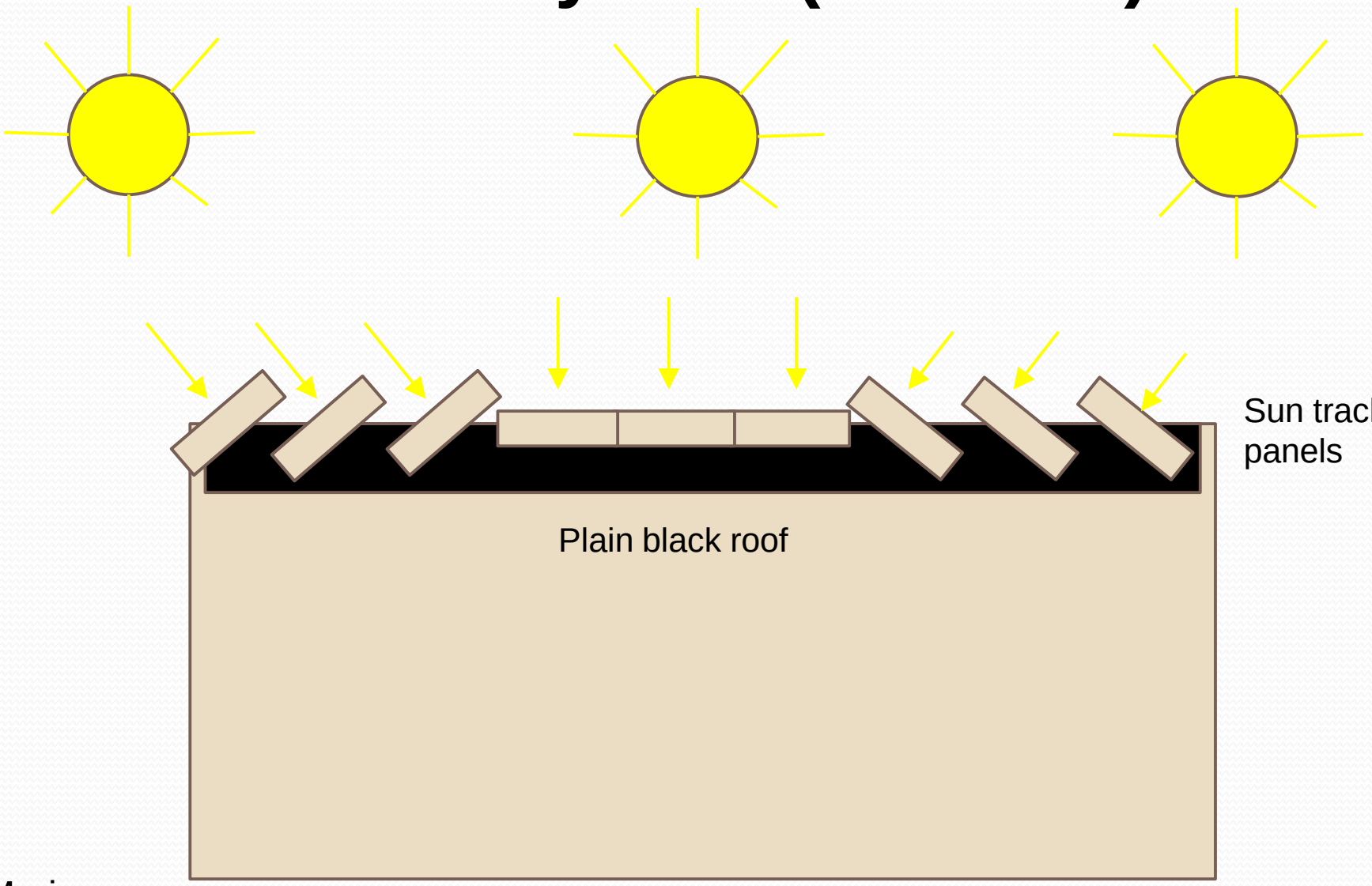
Winter sun

Summer sun

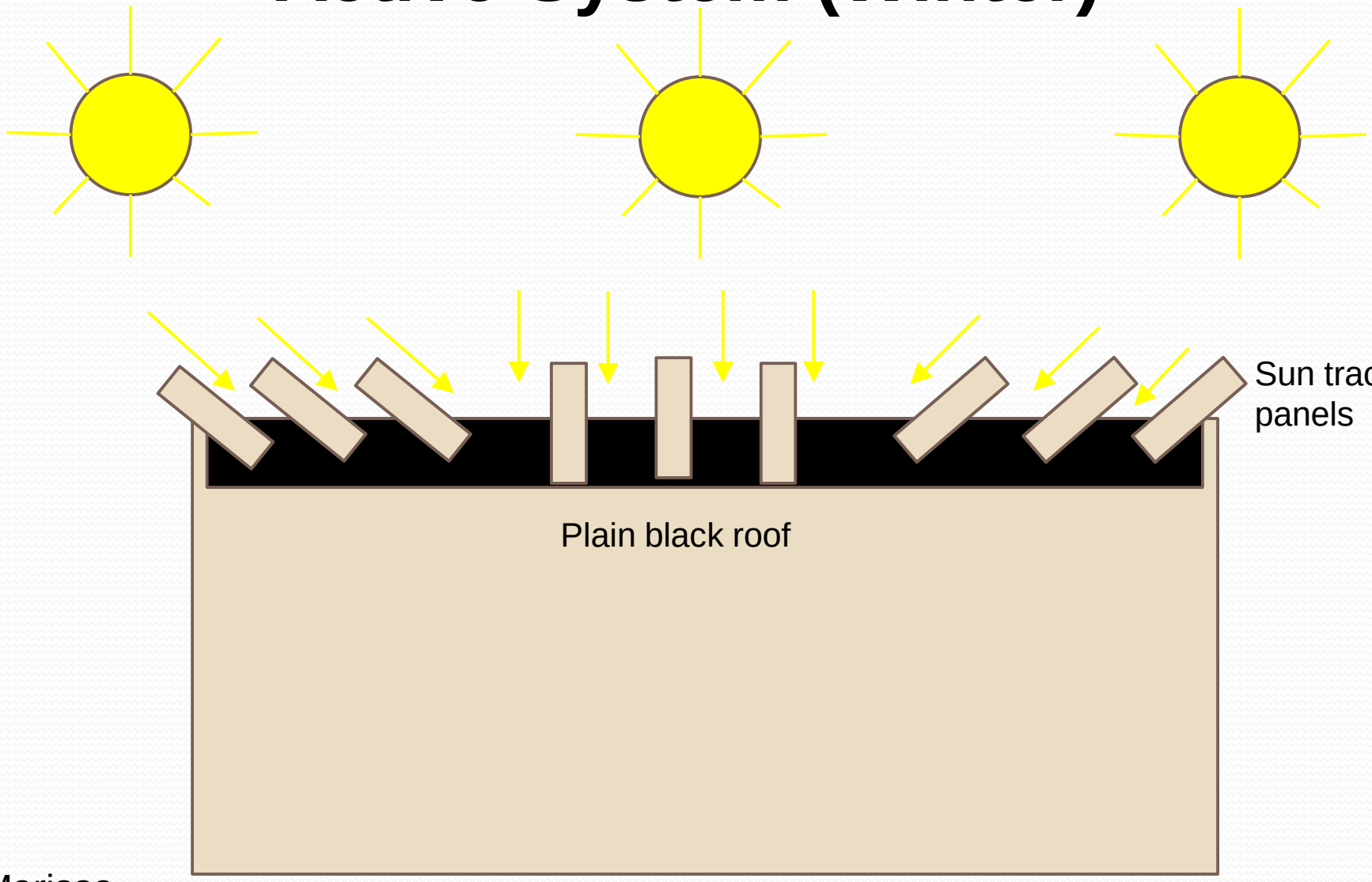




# Active System (Summer)



# Active System (Winter)



# Need Statement

- The amount of power usage to keep the interior of large buildings at a comfortable, cool temperature is too high.

# Project Goal

- To design and build roof system prototypes that can maintain the interior at constant temperature of a building model while using minimal power.

# Operating Conditions

- Design Effectiveness Analysis
  - Heat transfer & power consumption calculations will be done by hand

- Field test of Protoypes
  - Tests will be conducted outside and exposed to all environmental conditions

# Constraints

- The interior structure should maintain a 70$^{o}$F temperature at all times during the day and during any season
- The designs must be able to handle all weather conditions
  - Such as extreme heat, snow, strong wind, rain, etc.
- Stay within budget

# Project Objectives

| Objective | Measurement Basis | Units |
|---|---|---|
| Maintain Constant Internal Temperature | Interior Temperature of Structure Throughout a Day | degrees F |
| Reflect/Absorb the Sun's Radiation | External Roof Temperature Throughout a Day | degrees F |
| Low Power Usage | Power Used by Control, Active and Passive Roof to Maintain Internal Temperature | kWh |

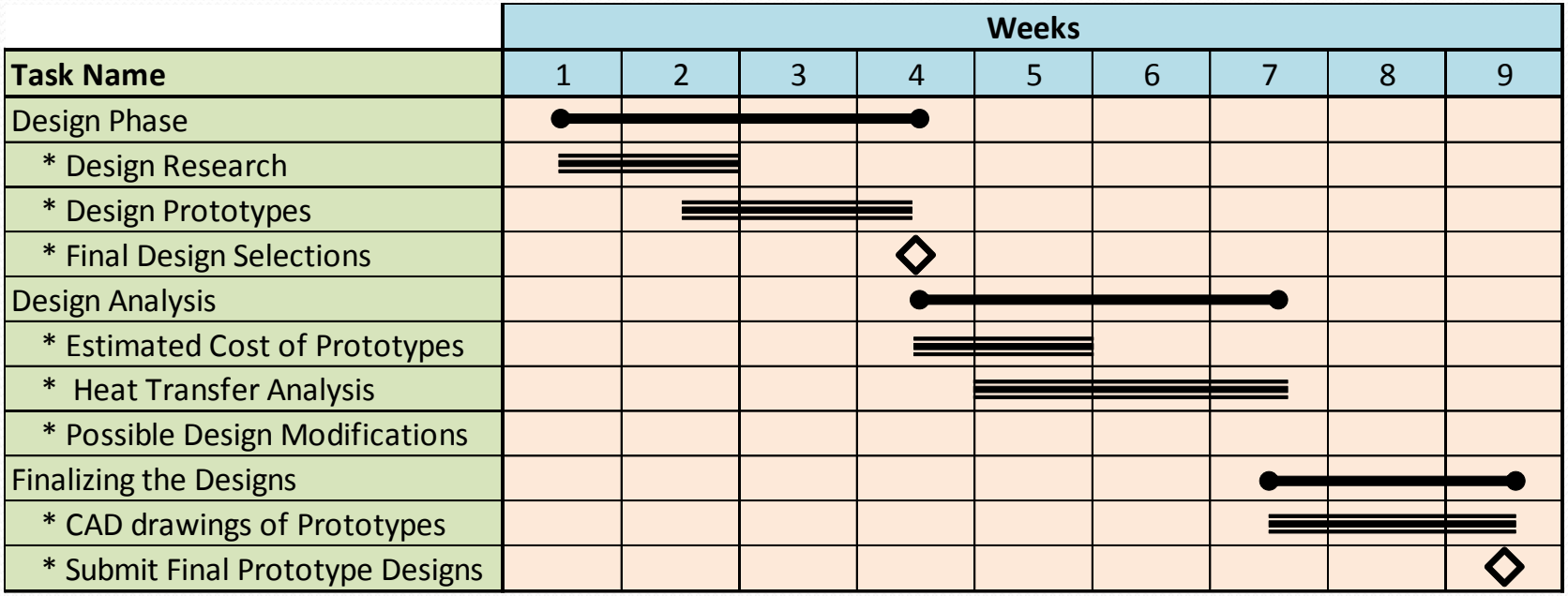
# Engineering Requirements for Analysis

- Material Strength (YS)
- Effiecency
- Weight
- Manufacturability
- Durable
- Functional
- Accuracy

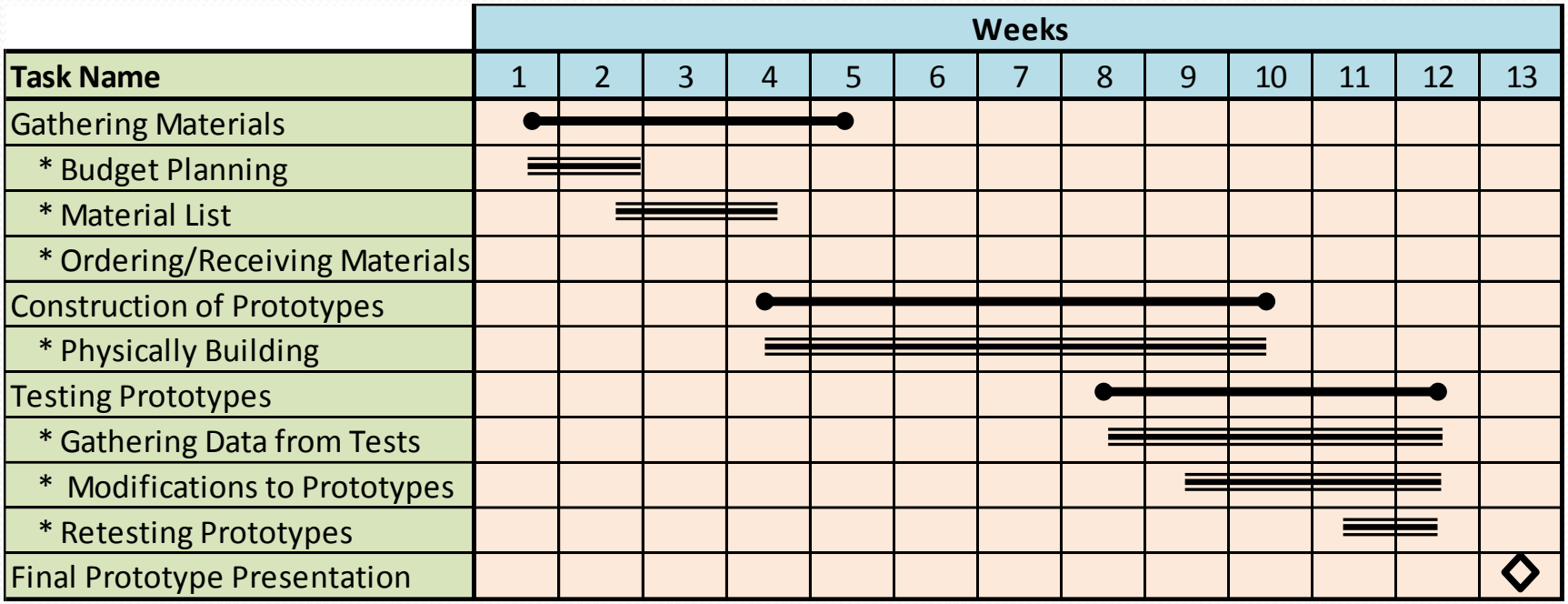
# Quality Function Deployment

| | | Engineering Requirements | | | | | | | Benchmarks | |
|---|---|---|---|---|---|---|---|---|---|---|
| Customer Needs | Customer Weights | Material Strength (YS) | Efficiency | Weight | Manufacturable | Durable | Functional | Accuracy | Active Design | Passive design |
| 1. Seasonal | 9 | 8 | 9 | 0 | 0 | 9 | 8 | 9 | X | X |
| 2. Light Weight | 4 | 2 | 0 | 10 | 0 | 7 | 5 | 0 | | X |
| 3. Low Cost | 10 | 4 | 6 | 9 | 8 | 5 | 9 | 7 | | X |
| 4. Minimum Power input | 10 | 0 | 9 | 0 | 0 | 0 | 0 | 6 | | X |
| 5. Stiff | 6 | 10 | 0 | 8 | 0 | 6 | 6 | 0 | X | X |
| 6. Efficiency | 8 | 0 | 10 | 0 | 0 | 4 | 9 | 8 | X | |
| 7. Easy to Control | 7 | 0 | 0 | 6 | 0 | 0 | 6 | 3 | | X |
| Unit of Measure | | psi | KWH | lb | Unitless | Unitless | Unitless | θ | | |
| | | Techical Target | | | | | | | | |

# Fall 2013 Project Planning and Design Phase



# Spring 2014 Construction and Testing Phase (Estimate)



# Conclusion

- Project Clients
  - Dr. Michael Shafer & Grant Masters
- Project Entails
  - Designing and Building Prototypes of Passive and Active Roof Systems that can:
    - Maintain an internal temperature of 70$^{o}$F
      - By reflecting/absorbing the sun's radiation
      - And while using minimal power
    - Withstand all weather conditions

# Conclusion Cont.

- Testing these prototypes against the control
  - Passive Roof ~ Stationary Panels
  - Active Roof ~ Solar Tracking Panels
  - Control Roof ~ Plain White Roof

# References


- M. Shafer, Interviewee, *Project Intro and Passive/Active Roof Designs.* [Interview]. 1 October 2013