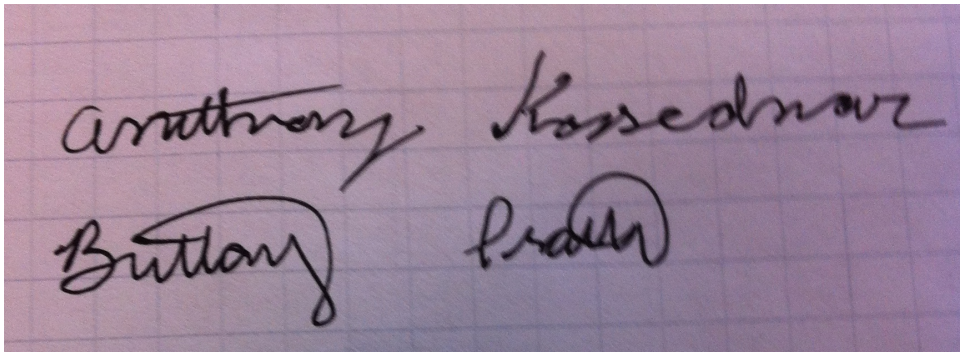
Sparkyville Solar Challenge
Final Report

December 11, 2012

Anthony Kosednar, Scott Molt, and Brittany Pratte
Team #5



Individual Contribution:

- Scott Molt (5%):
  - A few car body design sketches
  - Some axle mounting idea sketches
  - Sketched component layout on car body
  - Cut wooden axle mounts

- Brittany Pratte (47%):
  - Sanded axles
  - Mounted the axles
  - Mounted the solar panel
  - Helped write project deliverables
  - Mounted wheels
  - Cut chassis out
  - Secured wiring
  - Helped test

- Anthony Kosednar (48%):
  - Sanded axles
  - Mounted the axles
  - Mounted the solar panel
  - Helped write project deliverables
  - Mounted wheels
  - Cut chassis out
  - Secured wiring
  - Helped test
  - Soldered Circuit
  - Created final design sketches

Report Summary:

This report provides insight into the production of team 5's solar car through discussion of its design, building, and final results. Finally, the team commented on what was learned through the process and what could be done differently next time.

Introduction:

Purpose of this report is to provide the reader an overview of our Solar Car's conception, building, and overall finished product. First, the project's final status will be discussed, and then the original problem statement. After the key issues, conceptual design, and final design will be discussed before closing with the lessons that we have learned. At the end, an appendix of the project design notebook will also be included.

Project Status:

Currently the car is finished, and has competed in the solar challenge. In addition the Gantt chart (found at the end of this paper) was strictly followed and tasks were completed generally on time. In addition all deliverables were completed in a timely matter. In terms of race results, our car was able to complete 2 of 6 races. In the races that we were able to complete, we ranked 5 out of 10. As a whole though we ranked 10/10 as our solar panels were not configured for the orientation that we were racing.

Problem Statement:

A car is needed that uses renewable energy sources.

Need:

- Use renewable energy sources
- Travels Fast
- Cheap
- Small
- Durable
- Low Drag Coefficient

Objective:

- Create a car that uses renewable energy and wins the race.

Requirements:

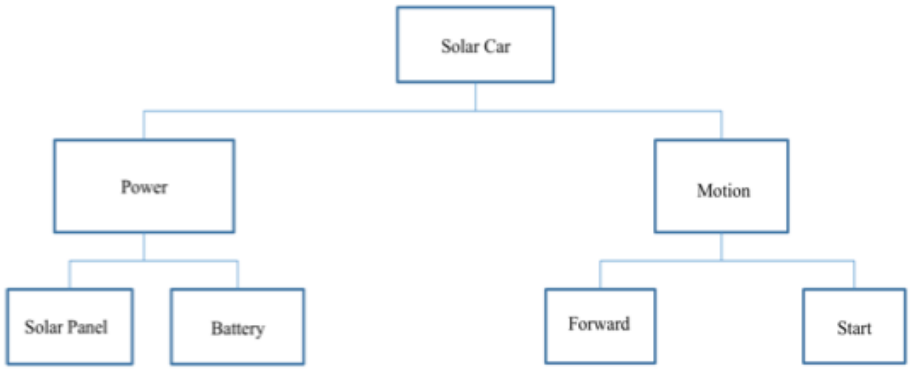
- Use Solar Power
- Be able to operate on battery only, solar power only, and a hybrid of both
- Be able to travel 50 ft.
- Cost less then $120
- Fit in e-space locker
- Use no fossil fuels

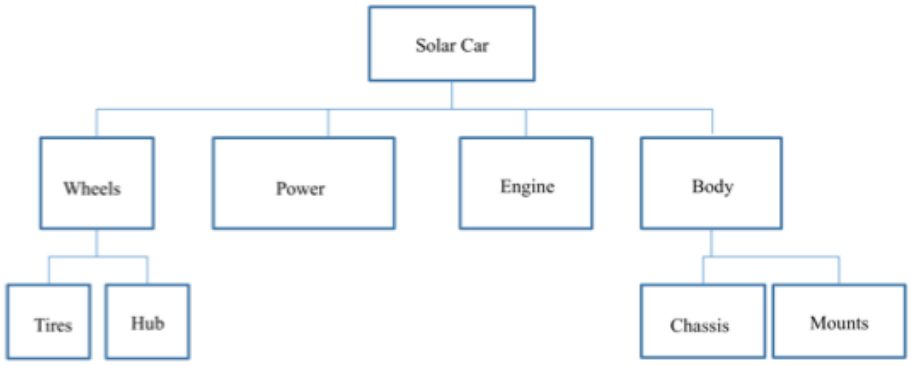
Technical Approach:

The key issues were to provide a car that not only traveled fast but utilized renewable energy while being small, cheap, and durable as well. In order to accomplish this, we first selected a highly efficient solar panel to contribute electricity to our circuit and provide a source of renewable energy as well. Next we selected the highest speed motor in order to gain the amount of force needed to go fast. Lastly, we selected plywood as our build material for the chassis, and mounts as well as aluminum rods for our axels as they are both lightweight and durable, but cheap as well.

Conceptual Design:

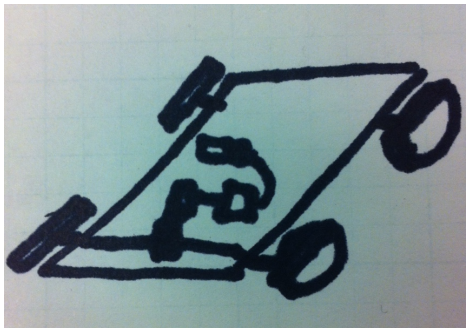
Below is the function decomposition diagram for a solar car:

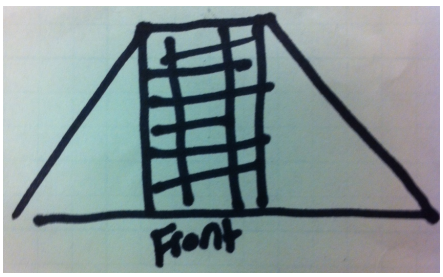




Proposed Solutions:

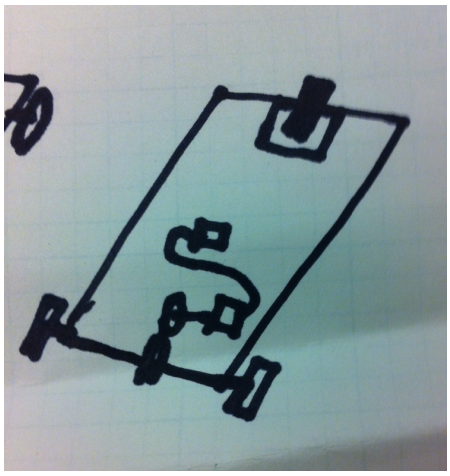
Solution #1 (Val. 1):
This solution would consist of a ply wood chassis with 4 wheels, 1 solar panel, the RS-380 PH motor, and a 9V battery. The front 2 wheels would be connected to the motor through gears, while the back two would be free spinning. The solar panel on top would be angled at 15 degrees in order to maximize the amount of sunlight received. This system would also include 2 switches. One would switch off the solar panel. The other would be to switch on/off the entire system. For the solar power only run, the battery pack will simply be removed.

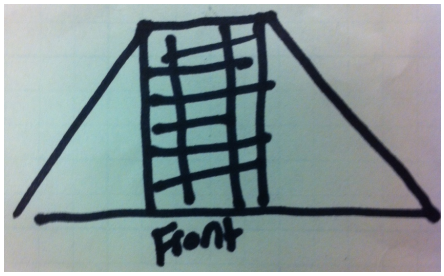




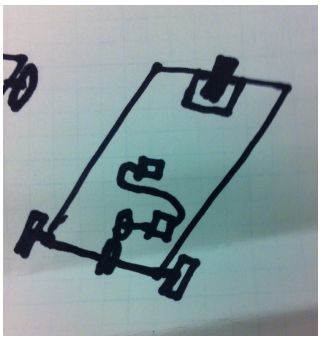
Solution #2 (Val. 2):

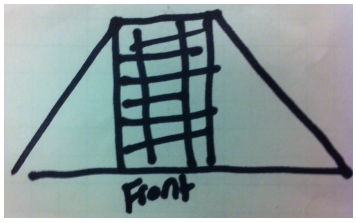
This solution would consist of a ply wood chassis with 3 wheels, 1 solar panel, the RS-380 PH motor, and a battery pack consisting of 8 AA batteries. The front 2 wheels would be connected to the motor through gears, while the back would be free spinning. The solar panel on top would be angled at 15 degrees in order to maximize the amount of sunlight received. This system would also include 2 switches. One would switch off the solar panel. The other would be to switch on/off the entire system. For the solar power only run, the battery pack will simply be removed. A battery pack that produced 18 Volts would be created from the set of 9V batteries.

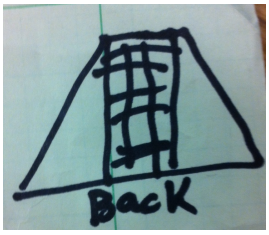




Solution #3 (Val. 3):
This solution would consist of a ply wood chassis with 3 wheels, 2 solar panel, the RS-380 PH motor, and a battery pack consisting of 2 9 Volt batteries. The front 2 wheels would be connected to the motor through gears, while the back would be free spinning. The solar panels would be angled at 15 degrees in order to maximize the amount of sunlight received. One would be in the front, while the other is in the back. This system would also include 2 switches. One would switch off the solar panel. The other would be to switch on/off the entire system. For the solar power only run, the battery pack will simply be removed. A battery pack that produced 18 Volts would be created from the set of 2 9 Volt Batteries.







Decision Matrix:

Below is the decision matrix used to evaluate the solutions. It was determined that sustainability was most important followed by speed and cost. Next was distance and finally size, and durability. Using this criteria each car was evaluated and solution #3 was determined to be the winner.

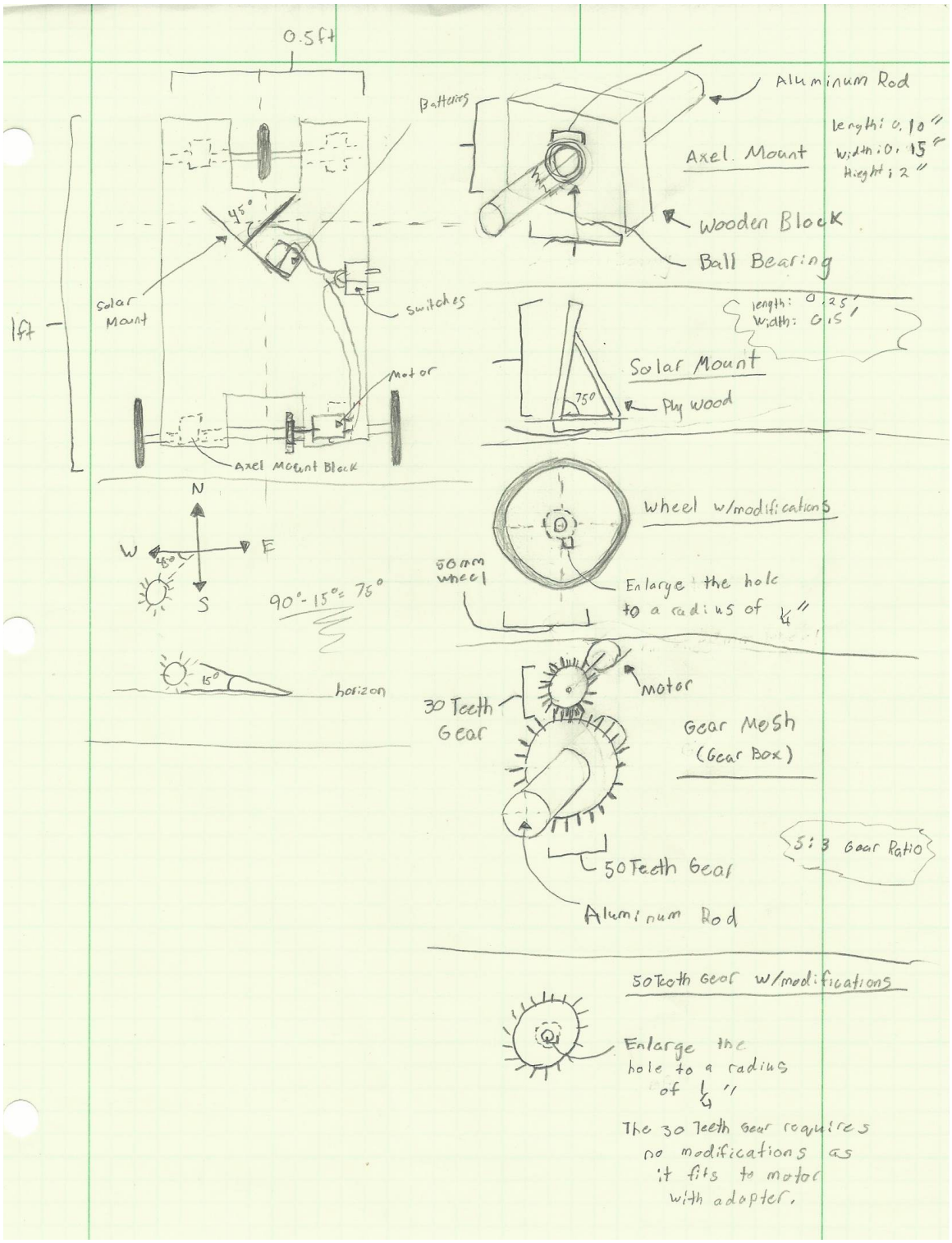
Evaluation Criteria	Wt.	Val1	Wt. Val1	Val2	Wt. Val2	Val3	Wt. Val3
Cost Effective	20%	6	1.2	7	1.4	2	0.4
Durable	5%	6	0.3	5	0.25	4	0.2
Sustainable	30%	7	2.1	7	2.1	8	2.4
Low Drag Coefficient	10%	8	0.8	9	0.9	2	0.2
Small in Size	5%	7	0.35	8	0.4	5	0.25
High Speed	20%	6	1.2	8	1.6	5	1
Long Distance Traveled	10%	5	0.5	8	0.8	9	0.9
Total	1	45	6.45	52	7.45	42	5.35

Final Design Description:

The final design consisted of a solar panel, 2 9v batteries, a rs-380ph motor, rectangular plywood chassis, and aluminum axel with ball bearings all held together by epoxy. It also includes the addition of rocks to help counter act some unbalances in the weight. This design is eco-friendly as it uses many naturally occurring resources. It is also simple and cheap which would make it easy to mass-produce. Finally the car is powerful and is able to carry a heavily load quite well.

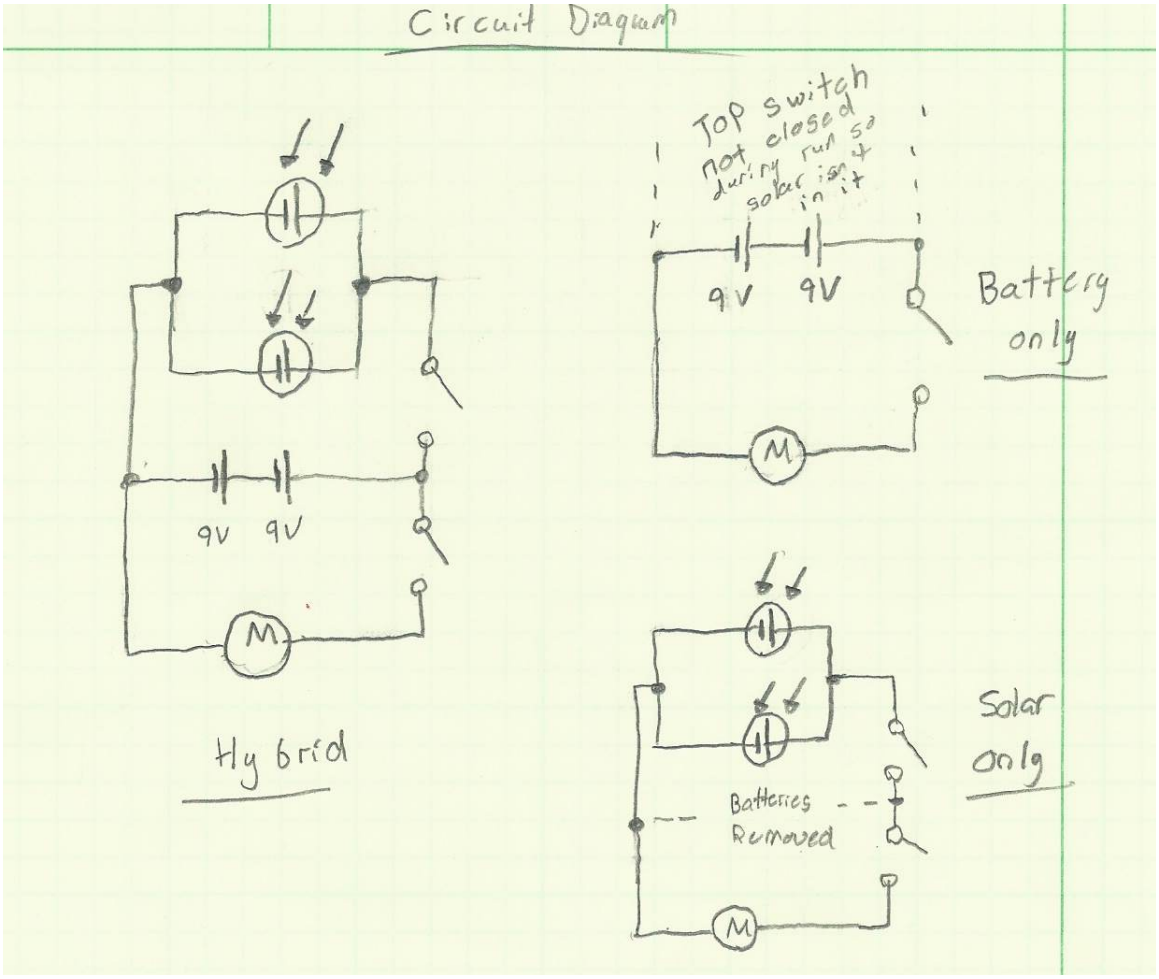
Final Design Sketch:

Below are our final design sketches and diagrams.



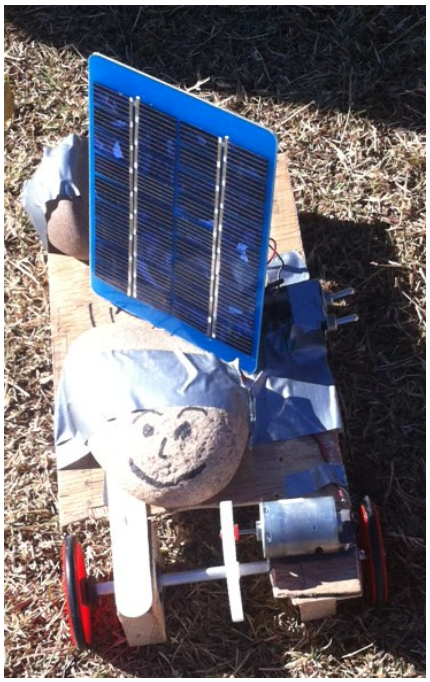
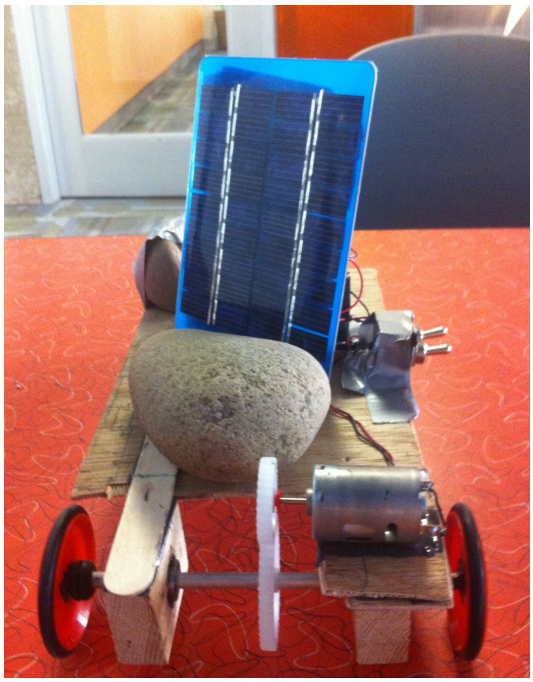
Final Design Circuit Diagram:

Below are our circuit diagrams for hybrid, battery, and solar. In the solar circuit, the batteries were taken out. In the battery circuit, the top switch was never close. As a result the circuit only functions as the circuit shown (as the top half wasn't actually in it if the switch was never closed). The complete circuit can be seen in the hybrid.



Final Design Photos:

Below are photos that display the final car produced:

Gear Ratio Analysis:

We first decided that a higher gear ratio would probably be needed in order to produce the amount of torque needed to make the car travel fast. Thus we tested 5:3, 5:2, and 5:1. On average 5:2 (50 teeth to 20 teeth) preformed the best. However, it did not mesh properly on the final configuration (it was too small). As a result the 5:3 ratio had to be used for the final build.

Materials List and Total Cost:

The following is a total of the materials purchased for the project:

- 1x 1.4W, 12V Kyocera Mini Solar Module ~ $29.00
- 1x 12 DC Motor RS-380PH ~ $3.50
- 2x 9V Battery ~ $0.30
- 2x 9V Battery Snap ~ $0.30
- 2x ON/OFF 2-way Toggle switch ~ $1.80
- 2x 1 ft Wire ~ $0.10
- 3x 50mm Wheel ~ $0.80
- 1x 25mm Wheel ~ $0.60
- 1x 50-tooth gear ~ $0.55
- 1x 30 tooth gear ~ $0.45
- 1x 1 sq foot 1/8” plywood ~ $0.70
- 1x 1ft 1/8” Aluminum rod ~ $0.35
- 4x 1/4" Ball Bearings ~ $1.00
- 6x 1/4" Rubber Grommets ~ $0.05
- 6x ¼” hose bracket - $0.10

  ~ Total: $47.45

What was actually used:

- 1x 1.4W, 12V Kyocera Mini Solar Module ~ $29.00
- 1x 12 DC Motor RS-380PH ~ $3.50
- 2x 9V Battery ~ $0.30
- 2x 9V Battery Snap ~ $0.30
- 2x ON/OFF 2-way Toggle switch ~ $1.80
- 2x 1 ft Wire ~ $0.10
- 3x 50mm Wheel ~ $0.80
- 1x 25mm Wheel ~ $0.60
- 1x 50-tooth gear ~ $0.55
- 1x 30 tooth gear ~ $0.45
- 0.5x 1 sq foot 1/8” plywood ~ $0.70
- 0.5x 1ft 1/8” Aluminum rod ~ $0.35
- 4x 1/4" Ball Bearings ~ $1.00
  ~ Total: $46.03

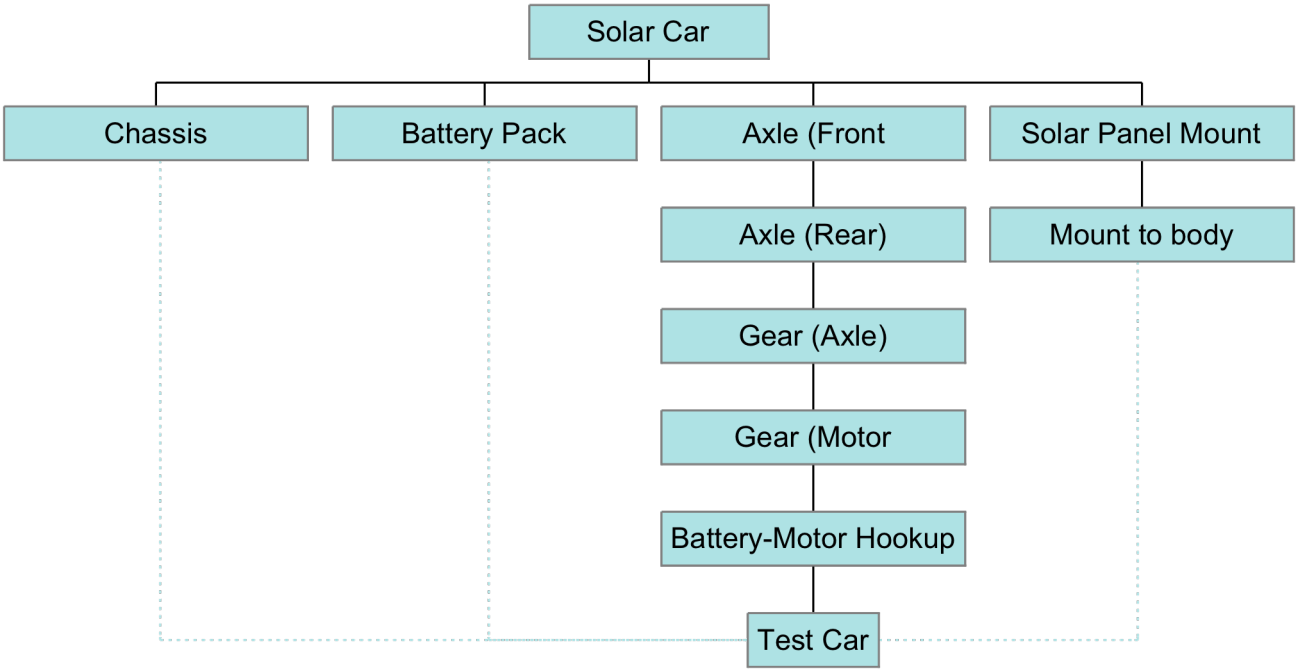
Lessons Learned:

From this project we have learned that you first off will encounter many unanticipated problems. As a result, in the future would create buffers in order to make sure that these unforeseen problems would not cause problems with our work schedule.

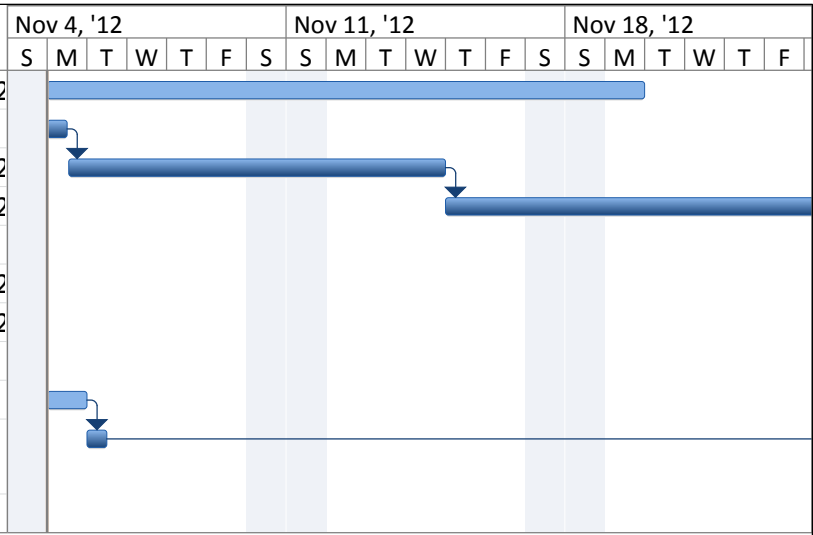
Next, we learned that it is highly important to validate your design and test throughout the build process. Little changes in the design may impact the final product. As a result, we would validate and test our design as we progressed.

Finally we learned that screws are not the best for securing objects and that if we would have gone with epoxy originally we could have avoided some unneeded work. As a result, in the future we would use epoxy instead of screws for most of the assembly process.

WBS

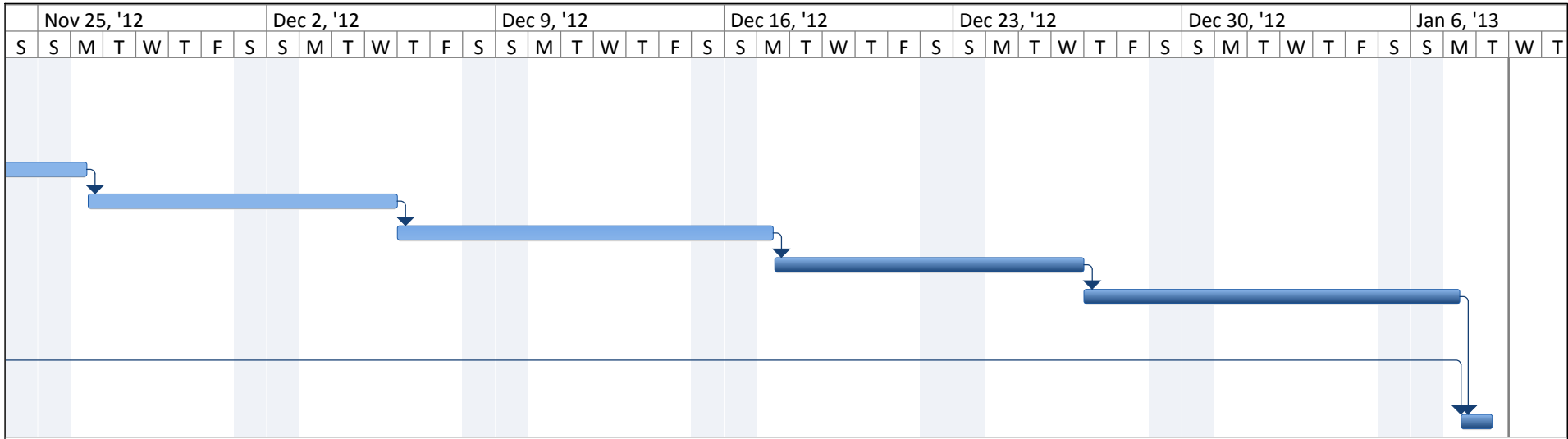

Solar Car
Chassis
Battery Pack
Axle (Front
Solar Panel Mount
Axle (Rear)
Mount to body
Gear (Axle)
Gear (Motor
Battery-Motor Hookup
Test Car

ID	Task Mode	Task Name	Duration	Start	Finish
1		Chassis	11 days	Mon 11/5/12	Mon 11/19/12
2		Battery Pack	0.5 days	Mon 11/5/12	Mon 11/5/12
3		Axle	7.5 days	Mon 11/5/12	Wed 11/14/12
4		Axle-front	7.5 days	Thu 11/15/12	Mon 11/26/12
5		Axle-rear	7.5 days	Mon 11/26/12	Wed 12/5/12
6		Gears	7.5 days	Thu 12/6/12	Mon 12/17/12
7		Motor Gears	7.5 days	Mon 12/17/12	Wed 12/26/12
8		Battery-Motor Hookup	7.5 days	Thu 12/27/12	Mon 1/7/13
9		Solar Panel Mount	1 day	Mon 11/5/12	Mon 11/5/12
10		Mount Solar Panel to Body	0.5 days	Tue 11/6/12	Tue 11/6/12
11		Test Car	1 day	Mon 1/7/13	Tue 1/8/13



Project: Project1
Date: Mon 11/5/12

Task		External Milestone		Manual Summary Rollup	
Split		Inactive Task		Manual Summary	
Milestone		Inactive Milestone		Start-only	
Summary		Inactive Summary		Finish-only	
Project Summary		Manual Task		Deadline	
External Tasks		Duration-only		Progress	



Project: Project1
Date: Mon 11/5/12

Task		External Milestone		Manual Summary Rollup	
Split		Inactive Task		Manual Summary	
Milestone		Inactive Milestone		Start-only	
Summary		Inactive Summary		Finish-only	
Project Summary		Manual Task		Deadline	
External Tasks		Duration-only		Progress	

Week #1

Tasks:

* Think of problem statement
  - Everyone
* ~~Gather Information~~
* Start writting Lab Book Thing → Anthony
* Put Lock on locker → Anthony

Lab Notes:

"A car that uses renewable energy is needed"

Requirements:
- $$ ~~$~~ < $120
- 3 diff power methods
  battery, no battery (solar), hybrid (solar + battery)
- Go 50 ft
- Low Cost
- Low Drag
- Durable
- Fit in espace locker

Need:
- self propelled
- use solar power

Objective:
- create a car that uses renewable energy

Summary:

We started discussing the basic info + project

Week #2

Tasks:

~ Generate, evaluate, & select design

Generate
- Chassis — Scott: Scott Molt
- Body Shell — Scott: Scott Molt
- Wheel — Brittany:
- Axle — Scott: Scott Molt
- Transmission + Motor — Anthony:
- Energy Sources — Anthony:
- Configuration

- Evaluate (Decision ~~Design~~ Matrix)
- Calculate Gear Ratios
- WBS + Gantt chart
- Start Prosposal

Lab Notes:

~ Transmission / Motor:

Anthony

Drive
- Rear: Takes more abuse, weight spread out, but more parts
- Front: More Traction but not good for high speed.

Motor
1. single motor for all gears not as powerful
2. powerful but might not be in sync

Transmission
1. ~~multiple gear~~ one gear + less complexity
2. multiple gears for diff speeds but more complex

Energy Sources
- Solar
- wind - no wind!!

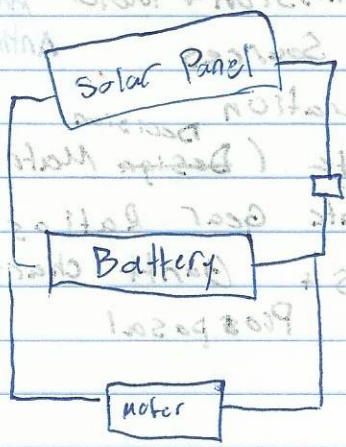
Brittany

Wheels:
- bigger wheel vs smaller wheel
  - → covers more distance
  - → able to support more weight
  - → requires more energy
  - → less aerodynamic
  - → more torque to accelerate to the same velocity
- 4 wheels, more stable

Battery

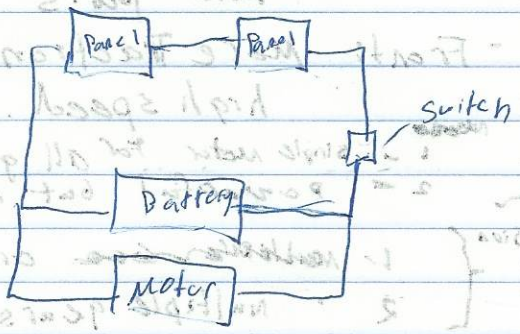
Electrical

#1

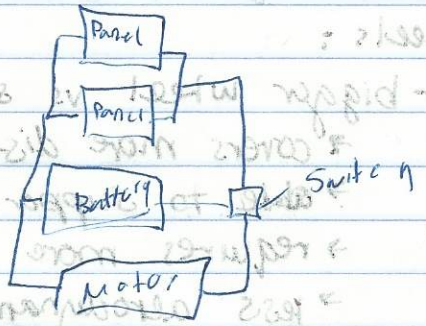


For the solar only we can just take out the battery

#2

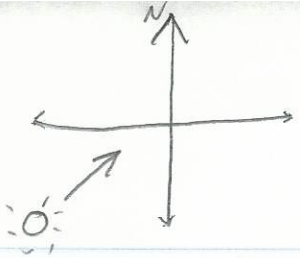


#3



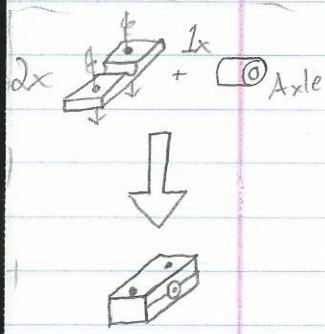
Anthony

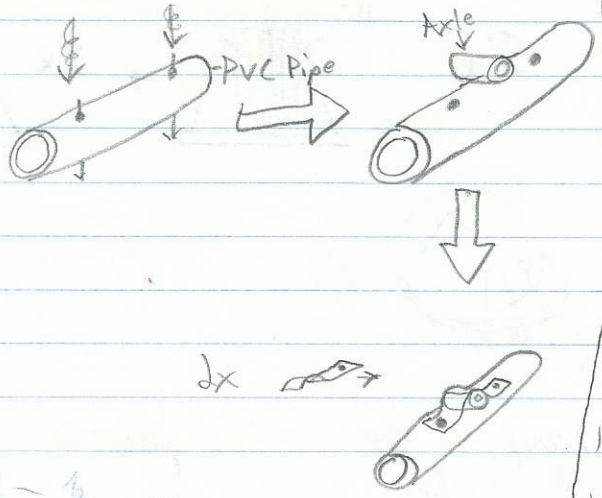
Axle Mounting
Chassis Design
Body Design on Reverse

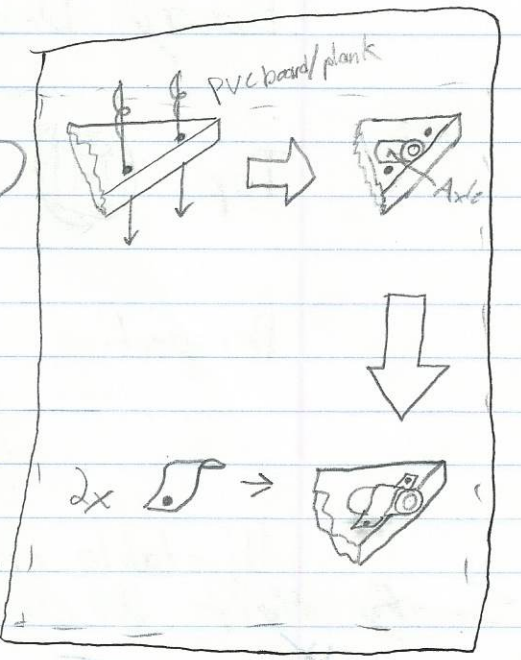


Chassis + Body

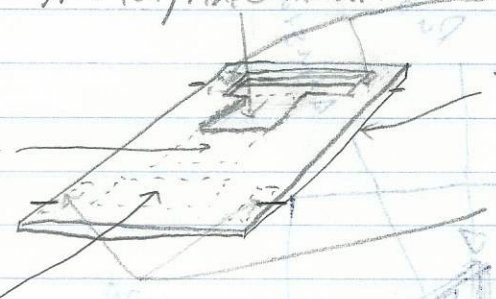
Axle Mounting



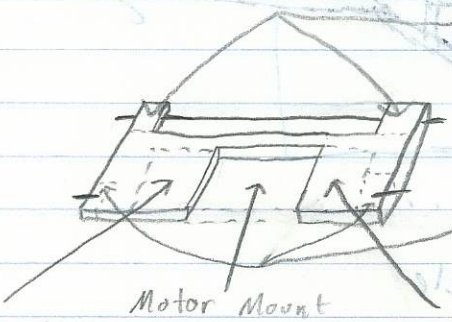




Large motor/gearbox
Equal weight distribution
Aerodynamic
1.



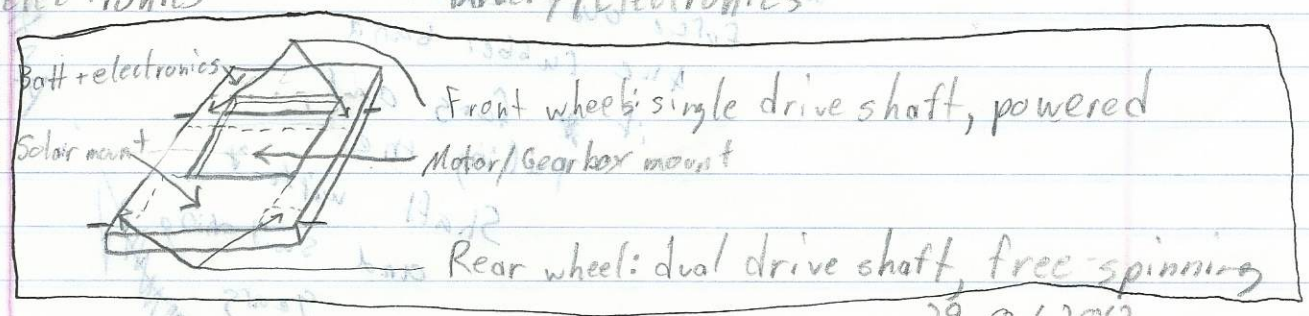
Off-balance
Would veer off-course
2.



Solar/electronics

Battery/Electronics

Balanced
Aerodynamic
3.



29 Oct 2012

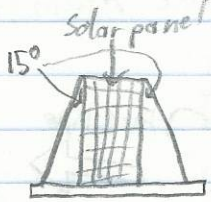
-Scott Molt

~~Final Design~~

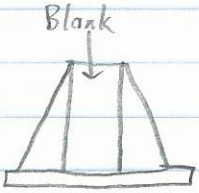
Body Design for Solar Array

Top

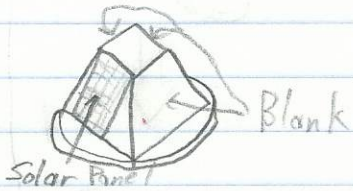
Side



+ 3x



Perspective

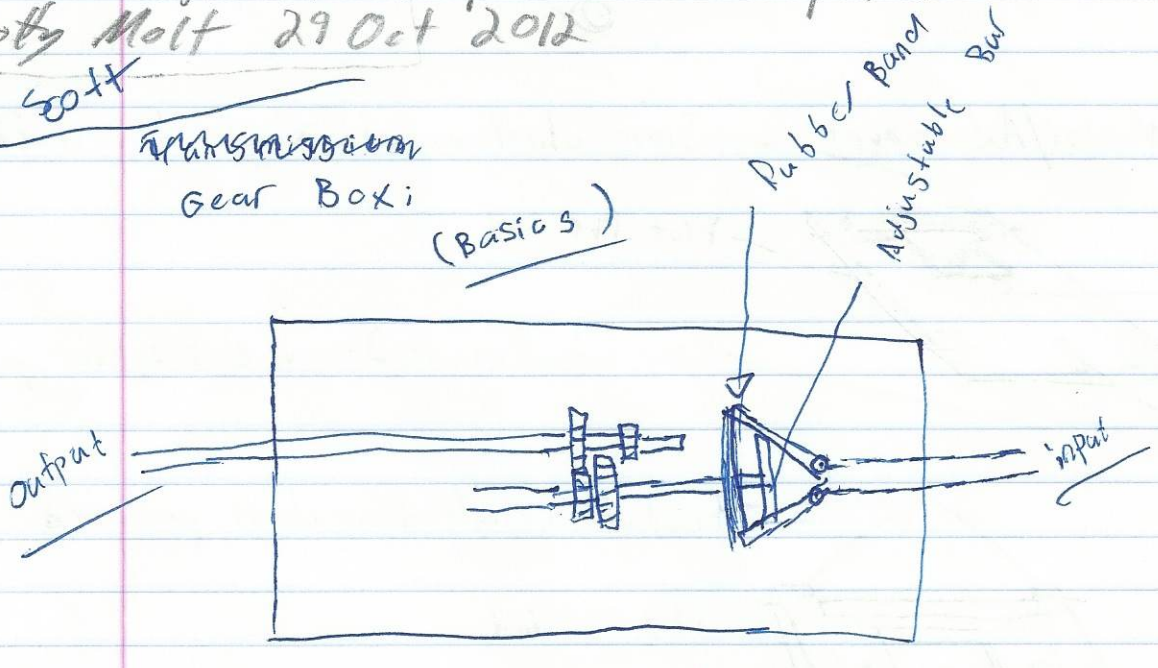


Adjustable clamp to secure in place

Scotty Molt 29 Oct 2012

Scott

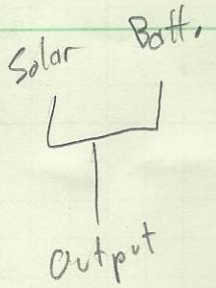
~~Transmission~~ Gear Box (Basics)

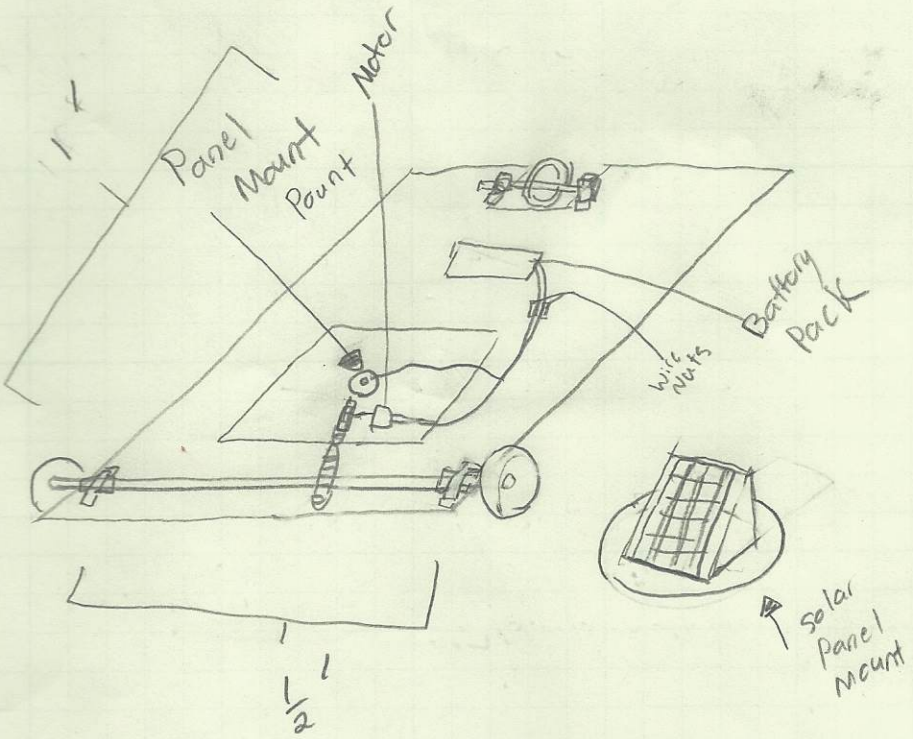


2 speed Design...

when the centrifical force over comes the rubber band it ~~*~~ funs out, pulling the shaft with it and switching gears

: Anthony





Anthony: Anthony Kossakowski

Summary:

29 Oct 2012

Scott - Drew Designs for Chassis, Axle mounts, and Solar Mount

Brittany - researched wheels, decision matrix, concept combination

Anthony - Design Transmission, Drive, Motor, Energy, Electrical

Nov # 5

Tasks:

- start Solar Panel Mount
- cut Chassis
- Purchase Parts
- test Motor, Battery Pack (Button)

Notes: See other Page

Summary:

Anthony: Helped cut chassis, Purchased Parts
Bittany: tested motor with 9V and 18V Button
Scott: Cut parts for solar mount+chassis Scott Molt

Nov 19th

* Power Tool Training
* Solder Training

Tasks:

A.) Buy Needed Parts:
- (2) 9V Battery snaps
- 1/4" aluminum rod
- (1) sprocket wheel (make sure it has to o-ring)
- 1/4" ball bearing (4)
- Measure length of ball bearing and buy hose bracket accordingly:
  - 3/16"
  - 1/4"
  - 5/16"
  - 3/8"
  (buy 4)

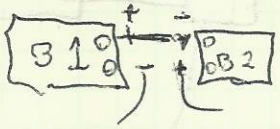
(2) toggle switch

Brittany / Anthony

Battery Shaft

B.) Create Battery Pack
- Electrical Tape Batteries together (make sure they are arranged right)
- Attach Battery snaps to 9V's
- Solder the snaps accordingly

Scott / Anthony



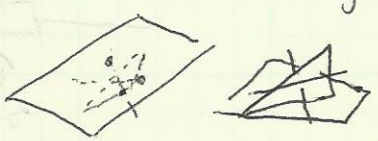
(So B1+ to B2- and B1- and B2+ be free)

C.) Mark where everything on the chassis should go
- Measure and draw/mark:
  * Solar Mount
  * Motor (make sure far enough back)
  * Ball Bearing Mount point
  * Back axel cut out
  * Battery Pack
  etc....

Brittany / Scott

D.) Redo solar Panel Mount + Continue
1.) Nail through sides (Make sure angled but Flat on top)

Brittany



2.) Bend ends of nails
3.) wood glue + set to dry

Brittany / Anthony

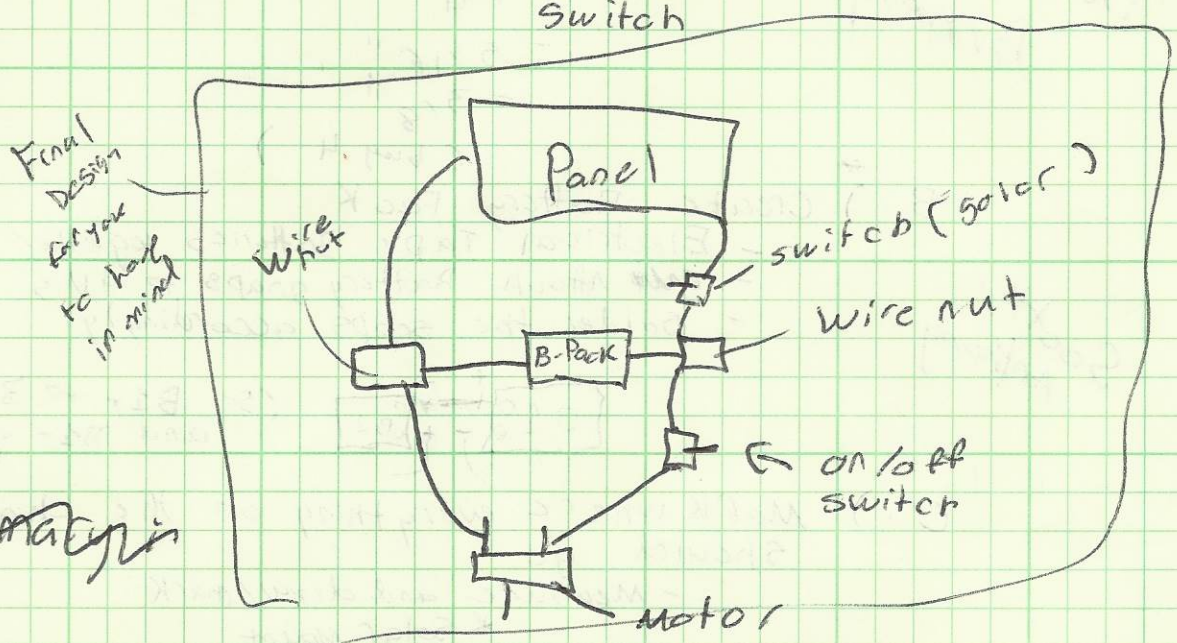
E.) Axels Stuff (some dependent on c)
1.) Cut rear axel area on back
2.) Drill 1/4" holes into wheels (all 3)
3.) Cut rod:
- Measure for back axel
- Measure for Front
4.) Make sure rod fits into ball bearings and sand them till they do. (snug fit)
5.) Attach ball bearings to chassis with hose brackets

6.) Attach back axel wheels to (all)
- wheel
- rod
- ball bearing
- wood glue

~~Nate Mateski~~

F.) ~~Sol~~ wiring

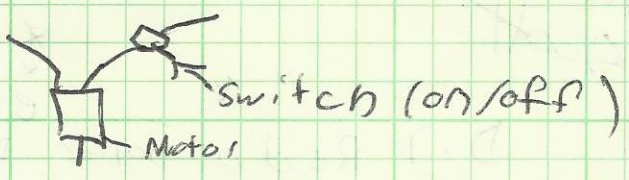
- Solder wires to Motor
  (Make sure to color code positive + negative)
- Solder Solar Panel Switch
- Solder on/off Switch



~~Schematic~~

1

& after we should have:



(Plus battery Pack from before)

G.) Figure out the resistor needed to get 2.28A in the circuit (colors of it too) you can combine multiple ~~r~~.

5 watt

Notes:

Panel = 6" x 11.5

Digikey P3.9BACT-ND

ERD-S2TJ3R9V

Summary:

Scott: Drew complete diagram of parts and electronics on board, soldered battery pack

Scott Molt

Anthony:

Buy Parts with Brittany
Helped tape battery, mount
worked on axel
manufactured hose clamps
Drilled Wheels
cut rod
Cut chassis back rear
Section cut

Brittany:

- Helped buy parts
- glued solar mount down
- filed down axle for ball bearings to fit
- helped screw solar mount in
- cut rod

Nov. 23rd

Tasks:

complete

Anthony circuit soldering

Notes:

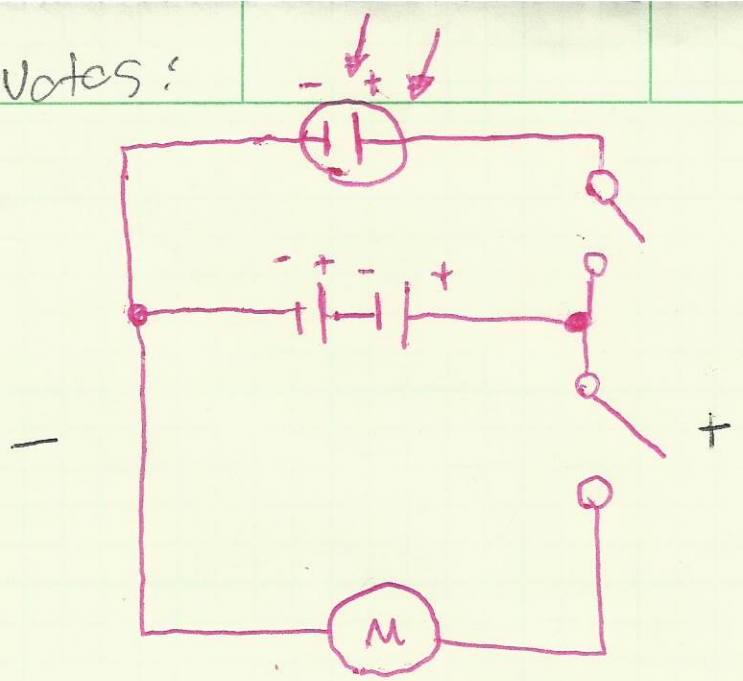


Fig. Circuit Diagram

Summary

Kinda cheated on switch wiring but it worked well and all wiring was completed

Anthony

Nov 26.

Tasks:

1 A.) Buy needed parts

- Gears: 0.55
  - 50 [illegible] - [illegible]
  - 20 [illegible] - 0.40
- Wheel [illegible] (50mm) - 0.80

2 B.) Mount Solar Mount to Car
↳ use nails?? (Quicker)

3 C.) Finish sanding axel

2 D.) Mount Solar Panel to Solar Mount

3 E.) - Mount gears on axel
- Mount axel to ball bearings
- Mount wheels onto axel
- Mount ball bearing to axel

3 F.) Mount motor + align gears

4 G.) [illegible] Secure wiring + switches

4 H.) Cut holes in unneeded chassis parts + reduce weight

G.) Test !!

Notes: Solar panel wasn't very secure with screws when attached to chassis

Summary:

Anthony: Bought parts, mounted Solar Panel, Created axel mounts [illegible]

Brittany: sanded axel, mounted solar panel, created axel mounts Brittany Pratt

Scott:

Fri. 30th

Tasks:

- Finish Axel Mounts
- Mount axels + Motors

Notes: solar panel wasn't very secure with screws

Summary:

Anthony: Mount axel + Motor, Redid Solar Panel Mount

Bittany: mount axel and motor, redid solar panel mount

Mon 3rd

Tasks:

A.) Mount + Glue Solar Panel correctly
BA.) Straighten axels
BB) Glue Axel Ball Bearings in place
~~C.) Glue wheel to axel~~
~~B.)~~
C.) Straighten wheels + glue to axel
D.) Glue Motor
F.) Re-Solder ~~motor~~ wires + secure
G.) Remove screws + Test

Notes: worked well! Hopefully every thing ends up well!

Summary:

Anthony + Brittany: mounted Panel, axel, & motor

Brittany

Fri 7th

Tasks: A.) Re glued Solar mount

B.) Glued backwheel

Notes: Wheels are hard to glue!!

Summary:

All Tasks - Anthony + Brittany

Brittany

Mon 10th

Tasks:

1.) Presentation

2.) test car

Notes: car didn't go straight so fixed with rocks (sorta)

Summary

All – Anthony & Brittany

Brittany