HYBRID MOBILITY DEVICE

CALIFORNIA STATE UNIVERSITY OF LOS ANGELES
COLLEGE OF ENGINEERING, COMPUTER SCIENCE AND TECHNOLOGY
ADVISOR: ADEL SHARIF
Agenda

- Introduction
- Project Management
- Mechanical Process
- Power System Process
- Design Assessment
- Conclusion
MECHANICAL SYSTEM TEAM

Cristopher Santiago  |  Abdullah Alshammari  |  Noemi Lucas  |  Christopher Perez  |  Hussam Alzahrani

- Mechanical Engineer
- Chain Guide
- Mechanism design
- Team Leader

- Mechanical Engineer
- Roll Cage
- Seat Design

- Mechanical Engineer
- FEA
- Drawings
- Seatbelt
- Safety

- Mechanical Engineer
- Design Gear
- Mechanism

- Mechanical Engineer
- Roll Cage
- Seat Design
POWER SYSTEM TEAM

Adrian Gonzalez - Mechanical Engineer
Battery Management

Brian Castillo - Electrical Engineer
Control Systems

Diego Monterroso - Mechanical Engineer
Solar Cell

Gavino Saenz - Mechanical Engineer
Solar Cell

Juan Estrada - Mechanical Engineer
Motor

Helen Cedillos - Mechanical Engineer
Control Systems
Team Leader
Problem - Transportation

- Global Warming
- Pollution
- Traffic
- Expensive
- Maintenance
SOLUTION

Eco-friendly

Health

Reduce Greenhouse Gas Emission

Cheaper alternative compared to vehicles.
SOCIETY IMPACT & FACTORS

• Encourage more efficient vehicles and a better way of commuting with minimal environmental impact
• Eliminate road congestion
• Lower Carbon Emissions
OBJECTIVE

Lightweight Hybrid Mobility Vehicle

- Alternate form of transportation
- Eco Friendly
- Slim tadpole design

Power System Team

- Design and integrate:
  - Electric Powertrain
  - Renewable Energy Source

Mechanical Systems Team

- Design a roll cage
- Finite Element Analysis (FEA)
- Finalize the drivetrain
Project Management

- Team Structure
- Work Breakdown Structure
- Deliverables
Mechanical Team

Advisor
Mike Thorburn

Advisor/Client
Adel Sharif

Team lead
Cristopher Santiago

Roll Cage
Abdullah/ Hussam

Roll Cage material (weight+ cost)
Abdullah/ Hussam

FEA
Noemi

Calculations
Noemi

Seat and Steering
Abdullah/ Hussam

Derailleur / Budget
Chris Perez

DRIVETRAIN
Cristopher S/ Christopher P

Chain/ Crank
Cristopher S

Chain Tube
Cristopher S
This part of the project were divided into 4 phases:

Phase I: Determining the essential parts of the project as well as doing research to better understand the project.

Phase II: Providing concept designs and move forward with final design.

Phase III: Testing and simulate

Phase IV: Finalize work, present final product.
## Work Breakdown Structure

<table>
<thead>
<tr>
<th>WBS</th>
<th>Task</th>
<th>Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Phase 1 - Research</strong></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Roll Cage</td>
<td>Hussam / Abdullah</td>
</tr>
<tr>
<td>1.2</td>
<td>Drivetrain</td>
<td>Cristopher S/ Christopher Perez</td>
</tr>
<tr>
<td>1.3</td>
<td>FEA (Finite Element Analysis)</td>
<td>Noemi</td>
</tr>
<tr>
<td>1.4</td>
<td>Seat</td>
<td>Cristopher S/Hussam / Abdullah</td>
</tr>
<tr>
<td></td>
<td><strong>Phase 2 - Design</strong></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Roll Cage</td>
<td>Hussam / Abdullah</td>
</tr>
<tr>
<td>2.2</td>
<td>Drivetrain</td>
<td>Cristopher S/ Christopher Perez</td>
</tr>
<tr>
<td>2.3</td>
<td>FEA (Finite Element Analysis)</td>
<td>Noemi</td>
</tr>
<tr>
<td>2.4</td>
<td>Seat Design</td>
<td>Hussam / Abdullah / Cristopher S</td>
</tr>
<tr>
<td></td>
<td><strong>Phase 3 - Build and Test or Simulations</strong></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Design Roll Cage/ Drivetrain</td>
<td>Mechanical Systems</td>
</tr>
<tr>
<td>3.2</td>
<td>Meet all Design Requirements</td>
<td>Mechanical Systems</td>
</tr>
<tr>
<td>3.3</td>
<td>Design Seat</td>
<td>Mechanical Systems</td>
</tr>
<tr>
<td>3.4</td>
<td>Present Modifications to Advisor</td>
<td>Mechanical Systems</td>
</tr>
<tr>
<td></td>
<td><strong>Phase 4 – Finalize and Present</strong></td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>Demonstrate Final Project</td>
<td>Mechanical Systems</td>
</tr>
<tr>
<td>4.2</td>
<td>Present</td>
<td>Mechanical Systems</td>
</tr>
</tbody>
</table>
DELIVERABLES

Phase I
Identify the main parts
Research to develop understanding

Phase II
Start designing
Integrate the subsystem together

Phase III
Building shall start
Testing
Stimulations will be created in the event the school does not open

Phase IV
Present Finish Product
## WORK BREAKDOWN STRUCTURE

<table>
<thead>
<tr>
<th>WBS</th>
<th>Task</th>
<th>Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Phase 1 - Research</strong></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Motor</td>
<td>Juan</td>
</tr>
<tr>
<td>1.2</td>
<td>Battery Management</td>
<td>Adrian</td>
</tr>
<tr>
<td>1.3</td>
<td>Control System</td>
<td>Brian/Helen</td>
</tr>
<tr>
<td>1.4</td>
<td>Solar Cells</td>
<td>Gavino/Diego/Brian</td>
</tr>
<tr>
<td></td>
<td><strong>Phase 2 – Design</strong></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Motor</td>
<td>Juan</td>
</tr>
<tr>
<td>2.2</td>
<td>Control System</td>
<td>Brian/Helen</td>
</tr>
<tr>
<td>2.3</td>
<td>Battery and Charging</td>
<td>Adrian/Brian/Helen</td>
</tr>
<tr>
<td>2.3.1</td>
<td>Set Up Dual Charging</td>
<td>Gavino/Diego/Brian</td>
</tr>
<tr>
<td>2.3.2</td>
<td>Set Up Battery Configuration</td>
<td>Brian/Gavino</td>
</tr>
<tr>
<td>2.4</td>
<td>Solar Cell</td>
<td>Diego/Gavino</td>
</tr>
<tr>
<td>2.4.1</td>
<td>Set Up Wiring Configuration</td>
<td>Gavino/Diego</td>
</tr>
<tr>
<td></td>
<td><strong>Phase 3– Build [Simulations] and Run Test</strong></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Create Solar Panels</td>
<td>Power System Team</td>
</tr>
<tr>
<td>3.2</td>
<td>Test Configuration</td>
<td>Power System Team</td>
</tr>
<tr>
<td>3.3</td>
<td>Make Modification</td>
<td>Power System Team</td>
</tr>
<tr>
<td></td>
<td><strong>Phase 4 – Finalize and Present</strong></td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>Demonstrate Final Project</td>
<td>Power System Team</td>
</tr>
<tr>
<td>4.2</td>
<td>Present</td>
<td>Power System Team</td>
</tr>
</tbody>
</table>
Power System Schedule

9/7/20 to 10/21

Phase 1: Research
- Motor
- Battery Management
- Control System
- Solar Cells

Phase 2: Design
- Motor
- Control System
- Battery and Charging
- Set up Dual Charge
- Set up Battery Configuration
- Solar Cells
- Set up Wiring Configuration
- Cooling
- PDR Fall Report
- Slides

Phase 3: Build and Test
- Create Solar Panels
- Test Configuration
- Make Modifications

Phase 4: Finalize
- Demonstrate Final Project
MECHANICAL SYSTEMS
ROLL CAGE DESIGN

- High risk and low safety.
- Research on roll cage designs.
- Not enough space to place solar cells to meet the electrical team needs.
- Started the design process to increase the safety and to take advantage of the space on top of the roll cage.
ROLL CAGE
New design

• 1. Designed a roll cage to protect the driver from being injured.

• 2. Mild steel were used to design the roll cage with 1-inch square tubing and 0.065 inch of wall thickness.

• 3. Increased the top space of the roll cage to place the solar cells.

• 4. Curved the corner of the roll cage to minimize the stress
ROLL CAGE - ANALYSIS

• If Analysis is done correctly, it reduces the time and cost when building.

• The material selected: Steel mild

• Multiple analysis was done on roll cage.
  • Front impact
  • Roll over
  • Side impact
Mild Steel

- 1-inch square tubing
- Primarily made up of steel or iron.
- Commonly used in fabrication
- Versatile
- Simple metal available when it comes to welding
- Least amount of PPE
FRONT IMPACT - ANALYSIS

- Total Mass: 400 lb.
- Initial velocity: 25 mph
- Work done: 11331 J
- Impact time: 0.25 s
- Acceleration: 44.7 m/s^2
- Displacement: 1.397 m
- Impact force: 8110 N
SIDE IMPACT - ANALYSIS

- Impact force 8110 N
- Located in 8 different nodes.
- Impact force each node 1013.75N
ROLL IMPACT - ANALYSIS
Seats Design

1. Designed a new seat that fits the dimension of the vehicle.

2. More comfortable and stable

3. Better grip and more secure while driving
Steering Wheels

- Design issues
- Modifications
- Interfere with pedaling
- This design better for steering
SUSPENSION

- Double wishbone suspension
- Kingpin inclination (KPI)
- Caster
- Ackermann steering
DRIVETRAIN

• Additional Crank Design
• Rear 9 speed sprocket
• Gears will allow the driver to pedal with ease in elevated area when driving manually
• Pros of the new design
• Cons of previous design how it interfered with the seat
Chain Tube

- L: 304.8 mm, I.D: 12.7 mm, O.D: 15.875 mm
- Avoid Chain grease on clothes
- Guides the chain to the front Crank set.
Derailleur

- Maximize Speed and efficiency
- Allows usage of gears on rear cassette
- Easy to install
- Affordable
Pedaling Speed

- Efficient crankset rpm = 70
- Speed varies on cog teeth
- Intermediate chainring is 1:1 ratio with crankset
- Speed range from 25.1 to 8.1 mph

\[
\text{Speed} = \text{Gr} \times \text{RPM} \times D \times \pi \times \frac{\text{miles}}{\text{in}} \times \frac{\text{min}}{\text{hr}}
\]

\[
\text{Gr} = \text{gear ratio}
\]

\[
\text{RPM} = \text{rotations per minute}
\]

\[
D = \text{diameter of the wheel}
\]

<table>
<thead>
<tr>
<th>Cog Teeth</th>
<th>Chainring Teeth</th>
<th>RPM</th>
<th>Speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td></td>
<td>48</td>
<td>25.1</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>70</td>
<td>21.2</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td>18.4</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td></td>
<td>16.2</td>
</tr>
<tr>
<td>20</td>
<td>48</td>
<td>70</td>
<td>13.8</td>
</tr>
<tr>
<td>23</td>
<td></td>
<td></td>
<td>12.0</td>
</tr>
<tr>
<td>26</td>
<td></td>
<td></td>
<td>10.7</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td>9.2</td>
</tr>
<tr>
<td>34</td>
<td></td>
<td></td>
<td>8.1</td>
</tr>
</tbody>
</table>
Power System Process
ELECTRICAL ARCHITECTURE OVERVIEW
MOTOR

- **48V 1800W Brushless Motor**
- **Sprocket: T8F 9T**
- **Efficiency: 80%**
- **Motor Weight: 11.7 lbs**
- **Current: 28A**
- **Horsepower: 1.6 HP**
Motor Calculations

\[ F_{\text{total}} = F_{\text{rolling Resistance}} + F_{\text{Gradient Resistance}} + F_{\text{air resistance}} \]

\[ F_{\text{rolling Resistance}} = C_r \times m \times a \]
- \( C_r \) = Coefficient of Rolling Resistance
- \( m \) = Mass of Vehicle (kg)
- \( a \) = Acceleration due to gravity (\( \frac{m}{s^2} \))

\[ F_{\text{gradient}} = m \times a \times \sin \theta \]
- \( m \) = Mass of Vehicle (kg)
- \( a \) = Acceleration due to gravity (\( \frac{m}{s^2} \))

\[ F_{\text{air resistance}} = 0.5 \left( \rho \times V^2 \times C_a \times A_f \right) \]
- \( \rho \) = Density of Air (\( \frac{kg}{m^3} \))
- \( V \) = Velocity of vehicle (\( \frac{m}{s} \))
- \( C_A \) = Coefficient of air resistance
- \( A_f \) = Front area of vehicle (\( m^2 \))
Advantages/disadvantages

- Direct current (DC) electrical current which only flows in one direction.
- Easy speed regulation and can also be used for immediate start and reverse motions.
- Fed power directly from the power source and requires little to no maintenance.
- Disadvantage is it requires a more complicated speed controller than a brushed motor and has higher initial cost.
BATTERY

• Two lithium-ion batteries are being used
• Batteries specs include:
  • 48 Volts
  • 2000 Watts
  • 20 Amp hours.
• Different adapters being viewed regarding its charging system (i.e., Hybrid Charge)
  • prominent choice - Anderson outlet connection
• As for battery life, this will depend on how much current is used by motor.
• Charging time depends on standard/fast current
Battery Selection Process

- Perform for a much longer lifespan
- They can withstand extreme low temperatures without failing
- Ideal for outdoor applications
- Lithium batteries are lighter than alkaline batteries
- They offer an advantage when used with portable devices
## Battery Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Voltage (V)</td>
<td>48v</td>
</tr>
<tr>
<td>Nominal Capacity (Ah)</td>
<td>20Ah</td>
</tr>
<tr>
<td>Source Resistance (mΩ)</td>
<td>about 20</td>
</tr>
<tr>
<td>Cell Specification</td>
<td>20Ah 3.7V</td>
</tr>
<tr>
<td>Cell Combination</td>
<td>20Ah 5x13s</td>
</tr>
<tr>
<td>Cell Size</td>
<td>18650</td>
</tr>
<tr>
<td>Cell Quantity (parallel*series)</td>
<td>20Ah 65pcs</td>
</tr>
<tr>
<td>Discharge Cutoff Voltage (V)</td>
<td>38+-1V</td>
</tr>
<tr>
<td>Charge Cutoff Voltage (V)</td>
<td>54.6V</td>
</tr>
<tr>
<td>Rated Discharge Current (A)</td>
<td>30A</td>
</tr>
<tr>
<td>Instantaneous Maximum Discharge Current (A)</td>
<td>90A</td>
</tr>
<tr>
<td>Maximum Continuous Discharge Current (A)</td>
<td>30A</td>
</tr>
<tr>
<td>Maximum Continuous Charge Current (A)</td>
<td>5A</td>
</tr>
<tr>
<td>Charge Mode</td>
<td>CC-CV</td>
</tr>
<tr>
<td>Standard Charge Current (A)</td>
<td>2A</td>
</tr>
<tr>
<td>Charge Time under Standard Charge Current</td>
<td>9hours</td>
</tr>
<tr>
<td>Fast Charge Current (A)</td>
<td>5A</td>
</tr>
<tr>
<td>Charge Time under Fast Charge Current</td>
<td>10hours</td>
</tr>
<tr>
<td>Charge Temperature Range</td>
<td>-20-55°C</td>
</tr>
<tr>
<td>Cell Size (L<em>W</em>T)</td>
<td>250<em>105</em>70mm</td>
</tr>
<tr>
<td>Battery Weight</td>
<td>About 20Ah 3kg.</td>
</tr>
<tr>
<td>Battery Power</td>
<td>1000W</td>
</tr>
</tbody>
</table>
How does it work

Stores chemical energy and converts it to electrical energy

The chemical reactions in a battery involve the flow of electrons from one material (electrode) to another, through an external circuit

The flow of electrons provides an electric current that can be used to do work
Throttle

• Twist grip throttle
• Similar like how a motorcycle or scooter operates
• Provides power to move HMD
• Allows non-use of physical energy
CONTROL SYSTEM

- Motor
- Throttle
- Wiring
- Safety Features
- **Motor Controller Specifications:**
  - Rated at: 48V DC/ 32A / 1800W
  - Efficiency : 95%
Charging

- Dual Charging
- MPPT Solar Charge Controller
- Current Losses
- Step Up Voltage/Voltage Matching
- Current protection
How do solar panels work?

- Photons knock electrons free from atoms to generate a flow of electricity
- Each cell is sandwiched by two slices of semi-conducting material
Solar Cell

- Polycrystalline vs Monocrystalline
  - Polycrystalline made up of silicon fragments
  - Monocrystalline single-crystal silicon
- Cost-effectiveness
- Deciding factor
# Solar Cell Comparison

<table>
<thead>
<tr>
<th></th>
<th>Monocrystalline</th>
<th>Polycrystalline</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size</strong></td>
<td>3 x 3 in</td>
<td>2 x 3 in</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>1.15 W</td>
<td>0.6 W</td>
</tr>
<tr>
<td><strong>Current</strong></td>
<td>2.25 A</td>
<td>1.2 A</td>
</tr>
<tr>
<td><strong>Price/Cell</strong></td>
<td>$1</td>
<td>$0.33</td>
</tr>
</tbody>
</table>
Solar Modules

- Series connection
- Every pair will have a bypass diode
  - Total 5 pairs
Solar Panel Configuration

• Roll Cage Area:
  Top Portion: 31x19 (in)
  Rear Portion: 29x19 (in)

• 10x6 Cell Configuration

• Panel Rated Output: 30V / 2.4A / 72W
• Total Rated Output: 144W / 30V / 4.8A
Additional Panels

• Triangular panels mounted on the left and right side
• Adds 24 W of power to the system
Considerations of Solar Panel Construction:

Thermal Aspect
Temperature vs. Efficiency

Bypass Diodes
Prevent Hot Spotting
Enclosure

2 – 4 mm acrylic sheets

Sealed with weather resistant caulking
Mounting
Simulink PV MPPT Model
Simulink PV Array Output
MPPT Current and Voltage

![Diagram of PV Voltage vs. Boosted Voltage and PV Current vs. MPPT Current]
Design Assessment
## RISK ANALYSIS - Personnel

<table>
<thead>
<tr>
<th>Risk</th>
<th>Cause of Risk</th>
<th>Effects of Risk</th>
<th>Risk Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Health Risks</strong></td>
<td>COVID-19</td>
<td>Pneumonia, respiratory failure, septic shock, flu, and death</td>
<td>Masks, Social Distancing</td>
</tr>
<tr>
<td><strong>Safety Hazards</strong></td>
<td>Welding</td>
<td>Burns, eye damage, electrical shock, cuts</td>
<td>Personal Protective Equipment (PPE)</td>
</tr>
<tr>
<td><strong>Physical Damage</strong></td>
<td>Manufacturing/Careless work</td>
<td>Injuries</td>
<td>Following proper protocols and instructions on how to manufacture</td>
</tr>
</tbody>
</table>
## Risk Analysis - Mechanical

<table>
<thead>
<tr>
<th>Risk</th>
<th>Cause of Risk</th>
<th>Effects of Risk</th>
<th>Risk Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stability &amp; Comfort</td>
<td>Seat mounting</td>
<td>Driver safety</td>
<td>Seat and thick lux foam</td>
</tr>
<tr>
<td>Driver safety</td>
<td>Driver being injured or ejected if there is an accident.</td>
<td>Driver safety</td>
<td>Three-point safety harness</td>
</tr>
<tr>
<td>Fire</td>
<td>Temperature and cell over-heating</td>
<td>Fire</td>
<td>Fire extinguisher</td>
</tr>
<tr>
<td>Driver safety</td>
<td>Debris intrusion into driver compartment</td>
<td>Driver safety</td>
<td>Metal firewall Body panels</td>
</tr>
<tr>
<td>Accident or roll over</td>
<td>Accident</td>
<td>Driver safety</td>
<td>Roll cage</td>
</tr>
<tr>
<td>Risk</td>
<td>Cause of Risk</td>
<td>Effects of Risk</td>
<td>Risk Mitigation</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-----------------------------</td>
<td>------------------------------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>Overheating</td>
<td>Temperature</td>
<td>Fire</td>
<td>Air cool</td>
</tr>
<tr>
<td>Hot-spotting</td>
<td>Cells over-heating</td>
<td>Fire/Solar panel failure</td>
<td>Bypass Diodes</td>
</tr>
<tr>
<td>Exposed wires</td>
<td>Shift in electrical components</td>
<td>Shock</td>
<td>Cable Ties/Wire Looming</td>
</tr>
<tr>
<td>Lithium Battery Leak</td>
<td>Battery Defect</td>
<td>Exposure can cause symptoms such as nausea, vomiting.</td>
<td>Storage, and regular inspection</td>
</tr>
</tbody>
</table>
## DESIGN BUDGET

<table>
<thead>
<tr>
<th>Part</th>
<th>Allowance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame</td>
<td>$200</td>
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<tr>
<td>Roll cage</td>
<td>$72</td>
</tr>
<tr>
<td>Seat</td>
<td>$200</td>
</tr>
<tr>
<td><strong>Drivetrain:</strong></td>
<td></td>
</tr>
<tr>
<td>Steering wheel</td>
<td>$50</td>
</tr>
<tr>
<td>Chainrings</td>
<td>2 x $30</td>
</tr>
<tr>
<td>Bottom Bracket</td>
<td>$20</td>
</tr>
<tr>
<td>2 Chains</td>
<td>2 x $11</td>
</tr>
<tr>
<td>Small Rear chain</td>
<td>$5</td>
</tr>
<tr>
<td>Derailleur</td>
<td>$30</td>
</tr>
<tr>
<td>Wheels</td>
<td>$100</td>
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<tr>
<td>Chain guides</td>
<td>$20</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>$287</strong></td>
</tr>
<tr>
<td><strong>Mechanical Total:</strong></td>
<td><strong>$800</strong></td>
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<tr>
<td>Battery</td>
<td>$200</td>
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<tr>
<td>Solar Cells</td>
<td>$120</td>
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<tr>
<td><strong>Tabbing wire/connections:</strong></td>
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</tr>
<tr>
<td>Tabbing/bus wire</td>
<td>$14.99</td>
</tr>
<tr>
<td>Bypass diodes</td>
<td>$6.99</td>
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<tr>
<td>16-gauge wire</td>
<td>$14</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$35.98</strong></td>
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<tr>
<td>Charge Controller</td>
<td>$38</td>
</tr>
<tr>
<td><strong>Electrical total:</strong></td>
<td><strong>$400</strong></td>
</tr>
<tr>
<td><strong>Total budget:</strong></td>
<td><strong>$1200</strong></td>
</tr>
</tbody>
</table>
CONCLUSION

• Roll cage design
• Finite Element Analysis
• Drivetrain Design
• Seat & Steering Wheel
• Solar Cell and Solar panel
• Wiring Schematics
• Battery
• Electrical simulations