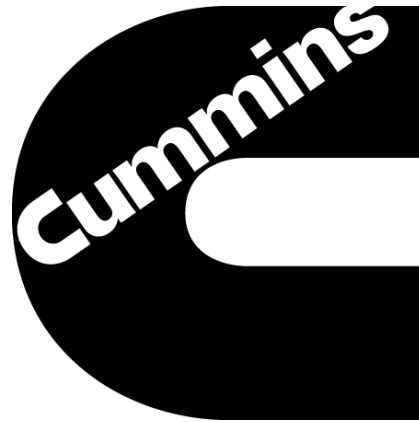


Electric Vehicle Range Extension

Team 2



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Presentation Overview

- Background
- Project Scope
- Overall Approach
- Project Progress
- Future Plans



Background

Cummins, Inc. & Electrical Power System Performance

- Advanced Batteries
- Upgraded Electronics
- Non-Traditional Power Adding Methods

Tasked with extending the range of a electric vehicle

- Tomberlin 48V Electric Low Speed Vehicle
 - Six – 8V Lead/Acid Batteries
 - Additional Generator
 - Range: 30+ miles
 - Max Speed: 25mph



Figure 1. Provided Tomberlin Electric Vehicle

Project Scope

Goal Statement

“To increase the range of the electric vehicle by at least 15% through non-traditional power adders while minimizing the reduction in acceleration and top speed.”

Objectives

- Procure/install additional power source
- Repair/finalize overall circuitry
- Document increase in vehicle range
- Optimize system to satisfy goals and constraints

Constraints

- Fuel supply cannot be increased
- Vehicle must be able to carry 4 people
- Top speed cannot be reduced by more than 10%
- Acceleration cannot be reduced by more than 10%

Project Approach

- Improve and reconfigure existing wiring
 - Organization
 - Weatherproofing components
- Optimize existing generator system
 - Continually charge batteries during use
- Install additional power source
 - Solar Panel System

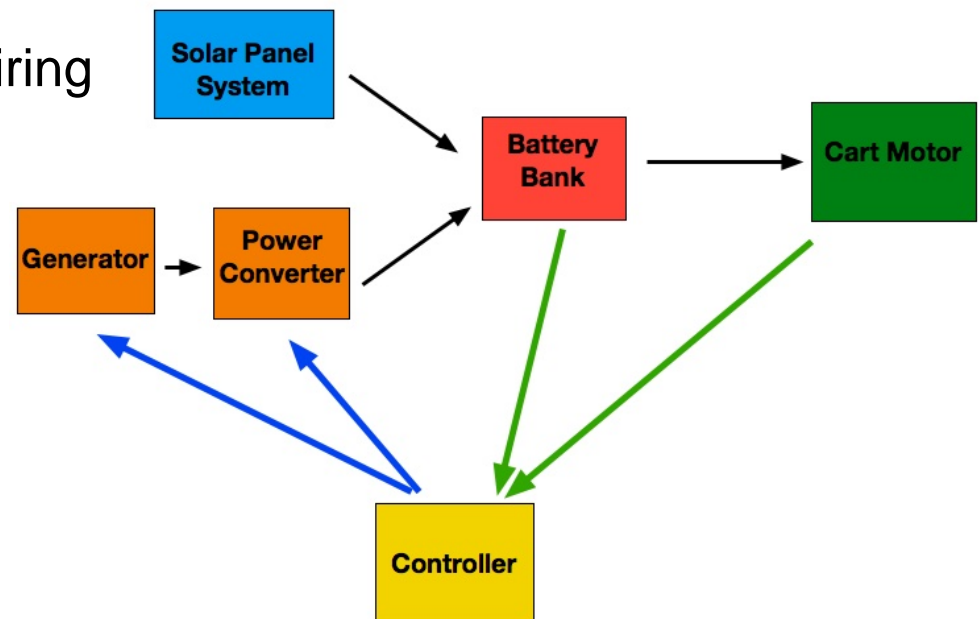


Figure 2. Overall system diagram

Project Progress

- Improved Wiring
- Improved Hardware
- Benchmark Testing
- Generator System Modification
- Additional Power Source Procurement Process

Wiring Improvements

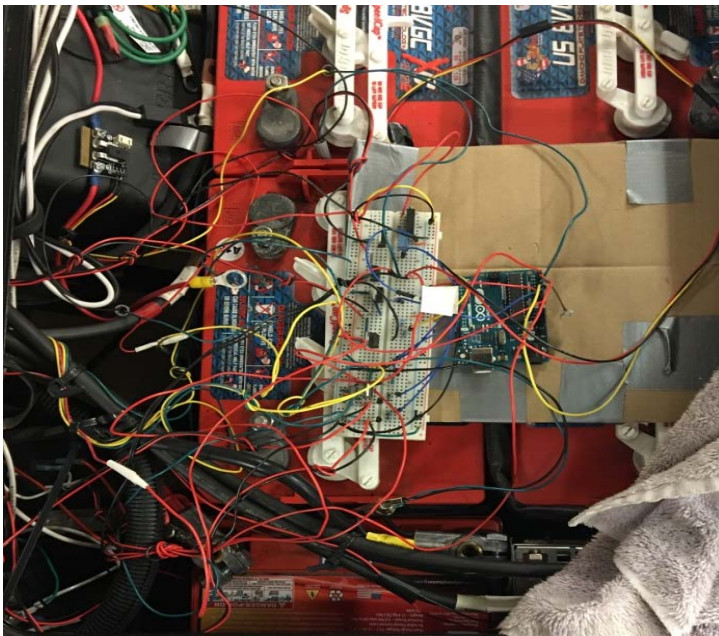


Figure 3. Original Circuitry Configuration

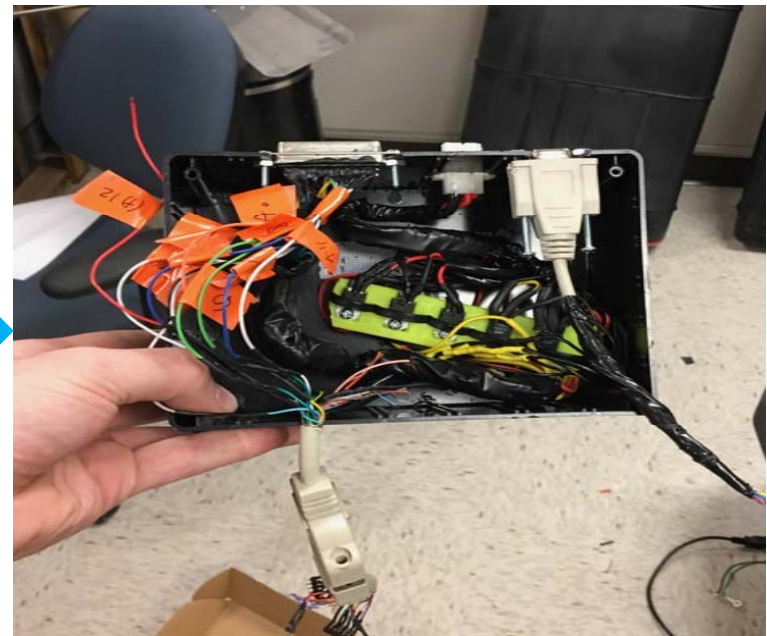
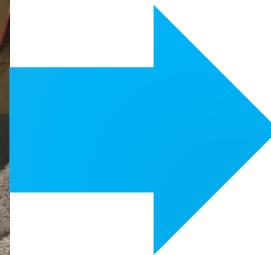


Figure 4. Updated Circuitry with Housing

Hardware Improvements

- 3D-Printed converter fan covers
- 3D-Printed LCD mount
- New LCD screen



Figure 5. New LCD with 3D-printed mount

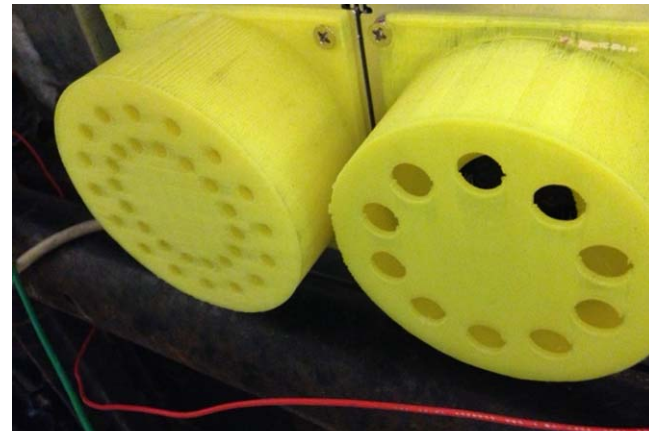


Figure 6. 3D-Printed converter fan covers

Benchmarking Tests

- Vehicle tested to determine current performance
- Battery Power Alone
 - Range: 22.3 miles
 - Speed: 25 mph
- Generator Power Alone
 - Range: 73.8 miles
 - Speed: 9mph
- **Theoretical Range: 96.1 miles**

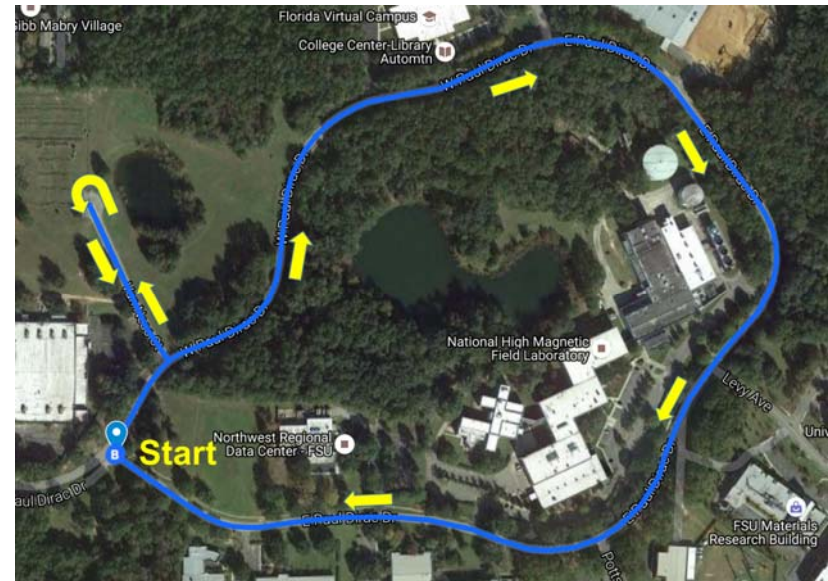


Figure 7. Selected Testing Track around W Paul Dirac Drive

Generator System Modification

- Original System
 - Either runs on generator or battery power
 - Simple, but not efficient or fast
- New System
 - Continually charges batteries
 - Motor is constantly supplied proper amperage
 - Requires complex code and electronics
 - More difficult to implement



Figure 8. Cummins QG2800 Generator

Additional Power Source

280w Solar Roof Replacement

- Manufactured to fit existing frame
- Up to 15 mile range increase
- Includes 97% efficient charge controller
- Cost: ~ \$1,500
- Currently in procurement process



Figure 9. Solar roof replacement example

Challenges

- Replicating test conditions
- Possible microcontroller coding issues
- Overall component circuitry
- Procurement process delays
- Ensuring electrical components aren't damaged



Spring Timeline

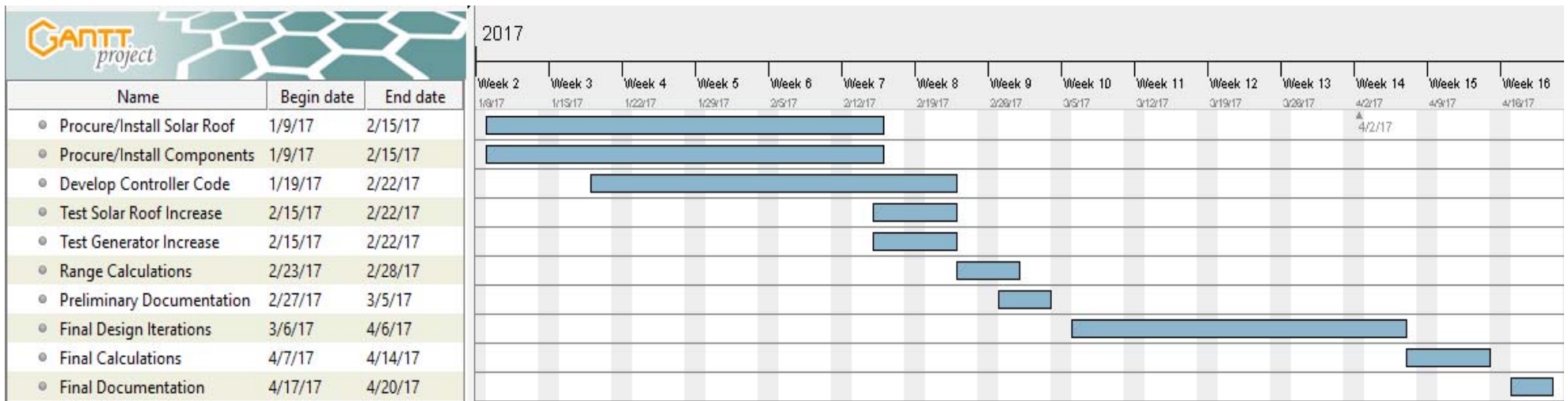


Figure 10. Gantt Chart for project planning

Project Summary

Goal Statement

“To increase the range of the electric vehicle by at least 15% through non-traditional power adders while minimizing the reduction in acceleration and top speed.”

Progress

- Wiring and hardware improvements
- Benchmark testing completed
- Generator system modified
- Currently procuring essential components

Future Plans

- Install solar system and electrical components
- Finalize overall circuitry
- Test vehicle to document range increase
- Further optimize and iterate final design

References

- [1] "Battery University" in BU-403: Charging Lead Acid. [Online].
- [2] "Product specs," Solar EV Systems - Solar Golf Carts, Roof, Tops, Solar Panel LSV Cart Kit for EZGO, Club Car, STAR, Yamaha, Bad Boy. [Online].
- [3] "How to charge sealed lead acid batteries," in Power Stream, 2000. [Online].
- [4] "RV generator set Quiet Gasoline TM Series RV QG 28 00," in Cummins Onan Specification Sheet. [Online].