Backwards Looking Summary

Situation:

Group A first investigated the topic of battery testing and used the reference AEV for the testing. Group A ran four tests with the first Lithium Polymer battery to see if and how the voltage would affect the performance of the AEV. For the fifth run, Group A got a new Lithium Polymer battery to also determine if and what the relationship was between the battery voltage, number of runs, and distance traveled. To conduct those tests, members would construct a code and run the AEV along the rails on the ceiling. A member would record the voltage of the battery before and after a test. Another member extracted the data from Arduino.

Group A then investigated the topic of motor configuration to choose which arrangement to use on the team's AEV. Group A made a code to perform test runs on the ceiling rails with four different motor configurations. The designs were both motors facing the front, back, one facing the front and one facing the back, and the other facing the front and the other facing the back of the AEV. Data was downloaded from the Arduino and put into a member's computer to determine which configuration was more efficient.

During and after battery testing and motor configuration, Group A had to complete a committee meeting, grant proposal, and research and development presentation. For the committee meeting, the human resources member, public relations member, and research and development members met with different people of the committee to talk about various subjects to check Group A's progress. Human resources discussed what the group had done and will do, team roles, and how the group interacted with each other. Public relations identified the audience, who Group A would be making the AEV for, and what and how the next steps would be achieved. Research and development defined any problems, the plan moving forward, and evaluated data points. The grant proposal was one PowerPoint slide that had what the part wanted was and the functions of the part. A member gave the presentation of why Group A should get the grant. The member talked about how the part wanted would benefit the group. The grant would better Group A's research and AEV. The research and development presentation was Group A giving a presentation to other groups and several PowerPoint slides with the main points of what was done and results including graphs of battery testing and motor configuration. The presentation was a way to inform other groups of their different research and findings.

Results & Analysis:

Throughout the course of the Advanced Research and Development labs, team A was able to make many observations about how the vehicle moves under different conditions. The team completed two different AR&D topics, which were the Motor Configuration lab, as well as the Battery Testing lab. Both contributed to the team having a better understanding of the AEV's performance in different situations.

Many of the observations were made during the motor configuration lab. During this portion of the lab, it was noted that the motors are more efficient when pulling the AEV, rather than pushing it. To further test this, the group created code which would run the AEV forwards

and backwards, noting if the vehicle would return to the starting position each time. The code was kept consistent between each run, only the positions of the motors were changed. The motors were run with both facing the front of the AEV, both facing the back, and then one front and one back, to test which configuration would yield the best results.

As can be seen in the power vs distance graph attached, the blue lines on the graph correspond to the first run which was completed. In the first peak, the distance traveled is much larger for a smaller power usage. In the second peak for the same run however, it is obvious that there is a much higher power draw for a smaller distance traveled. This allowed the team to see that having the motors in a pull configuration would be best for after picking up the caboose. It was also observed that during the fourth run, which was the opposite configuration as the first run, the results were opposite, which is the purple line on the graph. The results were so significant in fact, that the team had to stop the AEV early, as it almost went off the track when the motors switched to pulling the AEV. This is why the purple line abruptly drops off and the energy usage goes to zero.

The power vs time graph for the motor configuration portion shows a similar story. In each run, the results are consistent with the results observed by the team in the first and in the fourth run. The power required to push the AEV is much higher than the power required to pull the AEV. These two scenarios are denoted by the lower peak on the blue line being the pull situation, and the higher second peak being the push situation. It is also observed here that the second and third runs, where the motors are in opposite configurations, but working in tandem, the power draw falls in-between the other two configurations. The team took this into consideration when deciding on a final configuration, however it was noted that the AEV would have to pick up the caboose, so it was decided that the more efficient and powerful pull setup would be used to return to the starting position with the extra weight of the caboose.

The rest of the observations were made during the battery testing portion of the AR&D lab. The team noticed during this portion of testing, that the code used (which was kept consistent through each test, see below for actual code used) was not the best to use because of the inconsistencies with the power delivery. It was also observed that the batteries were overcharged to the point that they were reading 8.3v, not the advertised 7.4v. Whether or not this changed the results, the steps the team is planning to take to solve these issues should account for a drop in the voltage as well.

During the battery testing, it was observed that there were many inconsistencies between each run. For some runs, the AEV would go very far, however for others, the AEV would barely move. In the power vs distance graph attached for the battery testing lab, it is obvious that each run was wildly different, and the decrease in distance after each run was not consistent. An example of this can be seen between run 2 and run 3. Denoted by the orange and yellow lines, the distance for run 3 was significantly higher than the distance for run 2 even though the code was never changed. This may be attributed to the fact that the battery gives inconsistent voltage. Between run 2 and 3, the voltage dropped by .01v, which confuses the results even further.

Because of these confusing results, the team plans to implement a different set of functions to be sure that the AEV travels the same distance each time, rather than an inconsistent

distance. The team is planning to implement the gotoAbsolutePosition and gotoRelativePosition functions, rather than the goFor function, which will allow the AEV to only run for a set distance, rather than a set time. This will allow the AEV to have a more precise stopping point, as well as conserve energy which would be used to propel it further than need be.

Takeaways:

During the process of the Advanced Research and Development labs, team A observed several things that will be crucial for future aspects of the AEV. One of the main things that was further researched outside of the specific advanced research topics was the overall movement of the vehicle. This was primarily observed during the motor configuration tests. It was observed that the AEV was more energy efficient when it was in a pull orientation rather than a push orientation. This changed team A's initial design a great deal. Originally, the teams design would have been set to a pull orientation when heading towards the caboose, and then be set to a push orientation while traveling with the caboose. However, after learning about the energy efficiency difference between the orientations, the design was tweaked in order to move the caboose with a pull orientation as the vehicle will be heavier and therefore be less energy efficient with the caboose attached. The battery testing lab revealed some interesting issues with power delivery in the code implemented. There was a lot of inconsistency between runs, which can be attributed to the decreasing battery voltage between runs, or potentially the inherent issues with using the goFor() functions. It was observed that the goToRelativePosition() and the goToAbsolutePosition() functions would be both more useful and consistent. Team A will also be sure to have a fresh battery to maximize efficiency and maintain consistent results. These labs also taught team A about the importance of design iteration. During the two-different advanced research and development labs, two different AEV designs were used. The reference AEV was used for the battery testing, and an early team design was used for the motor configuration. This slight inconsistency could've lead to potential errors in the data. If given more time, team A recognizes that it would've been ideal to test these topics with multiple different designs. On top of this, team A was developing new and improved design concepts after each observation. Openness to design iteration and innovation to existing ideas is crucial for the success of the AEV project as a whole.

Forwards Looking Plan

Situation:

The upcoming week(s) for the AEV Project include: completing progress report 2, lab 9c where students will be completing the final R&D 1 (design concept comparison), complete performance test once and all necessary code, and plan for and complete the upcoming CDR draft (due 3/23/18), as well as complete their CATME evaluation due 03/25/18, and finally prepare for committee meeting 2 (03/29/18). Through the completion of these tasks within weeks 9 – 11, a better understanding of the completion of the AEV project as a whole will be obtained by the students.

The tasks are necessary to the AEV project because they will allow the students to begin compiling their research obtained in weeks 5-7 in order to prepare themselves to present their final findings at the conclusion of the Alternative Energy Vehicle project. The tasks will be completed in and outside of the classroom as well as an opportunity to share brain storming ideas in a group message or over email for the team. Weeks 9-11 are crucial for the students' overall success of the AEV due to the amount of information that will be learned through Performance Test 1, and the CDR Draft. By completing the following outlined weekly goals, Group A will be successful in their upcoming final presentation of their AEV Project.

Weekly Goals:

Goals for the Week Include:

1. Complete Progress Report 2 by Friday of Week 9
2. Begin Performance Testing
3. Begin individual parts of CDR Draft

The Progress Report will be completed by the entire team by Friday with Elle completing all of the forwards looking plan, Michael handling all of the code and takeaways form the backwards looking summary, Phil will complete the results and analysis and the additional graphs required, and Anna will complete the BLS situation. The group will also begin brainstorming and testing code for the performance test as well as start gathering all materials for the CDR draft that will be completed by 03/23/18.

Weekly Schedule:

Tasks to complete for Weeks 9-11:

1. Complete Performance Test One – due by Lab 9c (03/19/18)
2. Final R&D: Operational Objectives (03/19/18)
3. Complete the CDR Draft – due by Lab 10a (3/23/19)
4. Prep for Committee Meeting Two (03/29/18)

The completion of performance test 1 will be completed in class by mostly Phil and Michael since they have been doing most of the coding for the Arduino and also handling most of the design process thus far. Group A has also planned to split up the CDR Draft into equal sections, and work to complete the individual sections will mostly be done outside of class with some

work being done during class if time allows. The preparation for committee meeting will be mostly the task of Anna and Elle. The preparation will be individual to the specific meetings held i.e. HR, PR, and Research and Development.

Appendix

Appendix A: Team Meeting Notes:

Team Meeting Notes
Week: 5
Location: Hitchcock 324
Time: 9:00 AM
Attendees: Elle Marquez, Phillip Da Silva, Michael Gregg, Anna Cutno

Meeting Objective:

The objective of this meeting was to select the Advanced Research and Development topics, and also complete the Grant Proposal as well as prepare for Committee Meeting 1. Team members worked together to complete these tasks in a timely manner.

Previous Meeting Topics:

The objective of the previous meeting was to brainstorm ideas and designs for the final AEV design. Members also scored the AEV designs based on a list of criteria through concept screening and concept scoring.

Topics Discussed:

1. Selection of Advanced Research and Development Topics
    a. Motor Configuration
    b. Batter Testing
2. Labs 4-6 Progress Report Questions
    a. Complete questions to assist in writing Progress Report 2

Upcoming tasks:

Anna – Website Update 3.
Phillip – Build Final AEV design.
Michael – Continue working on Progress Report Questions and updating the Arduino Code.
Elle – Continue working on Progress Report Questions and compiling data for the Committee Meeting and Grant Proposal.

Assigned to Entire Team -

1. Battery Testing Research
2. Motor Configuration Research
3. Email Anna individual parts for Website Update 3

Timeline:

Complete Lab 05 website deliverables and Progress Report 2 by 03/09/18

Decisions made by the group:

Main AEV designs decided upon, minor tweaks still able to be made for caboose space. Also, the motor configuration allowed for the information to make the final AEV design i.e. motors in the back with pull in the first direction.

Reflection

The aR&D allows for the team to have a plethora of information to come up with the ideal AEV design.

Team Meeting Notes
Week: 7
Location: Hitchcock 224
Time: 9:35 AM
Attendees: Elle Marquez, Phillip Da Silva, Michael Gregg, Anna Cutno

Meeting Objective:

The objective of this meeting was to decide on a final AEV design, and to complete the Advanced Research and Development. Team members collaborated and tested the design to finalize their AEV based on the results from the advanced research topics: Battery Testing and Motor Configuration.

Previous Meeting Topics:

The objective of the previous meeting was to select the Advanced Research and Development topics, and also complete the Grant Proposal as well as prepare for Committee Meeting 1. Team members worked together to complete these tasks in a timely manner.

Topics Discussed:

1. Progress Report 2
    a. Assign section topics to team members
2. Performance Test 1
    a. Use all information gathered thus far to complete the performance testing on the main tracks.
3. CDR
    a. Complete performance tests and discuss results.

Upcoming tasks:

Anna – All upcoming website deliverables and website update
Phillip – Assist in completion of Performance Test One – due by Lab 9c
Michael – Assist in completion of Performance Test One – due by Lab 9c
Elle – Head the completion of the CDR Draft – due by Lab 10a (3/23/19)

Assigned to Entire Team –

Final R&D: Operational Objectives
CDR Draft
Prep for Committee Meeting Two

Timeline:

Complete Performance Test One – Lab 9c
CDR Draft – 03/23/18
Committee Meeting Two – 03/29/18

Decisions made by the group:

The final AEV design was selected as well as tested. Also, the research gathered from the advanced R&D was made into graphs (shown below).

Reflection on previous assignment:

The Advanced Research and Development is crucial to the AEV project in order for the group to outline key concepts to further their design in order to construct an optimal Alternative Energy Vehicle.

Appendix B: Arduino Code:

```
//Battery Test Code

 celerate(4,0,20,3); //accelerate motor 1 from 0 - 15 % in 2.5 seconds
 goFor(3); // move at 15% for  second
 celerate(4,20,35,1);
 brake(4); // brake motor 4
 reverse(4);
 motorSpeed(4,10);
 goFor(1);
 brake(4);
 celerate(4,0,20,2);
 goFor(3);
 brake(4);
 reverse(4);
 motorSpeed(4,10);
 goFor(1);
 brake(4);
```

ORIGINAL

```
//Motor configuration programming
 //2-20-18

 //check both motors functionality
 reverse(4);
 celerate(4,0,25,2);
 goFor(3);
 celerate(4,25,0,2);
 brake(4);
 reverse(4);
 celerate(4,0,25,2);
 goFor(3);
 celerate(4,25,0,2);
 brake(4);
```

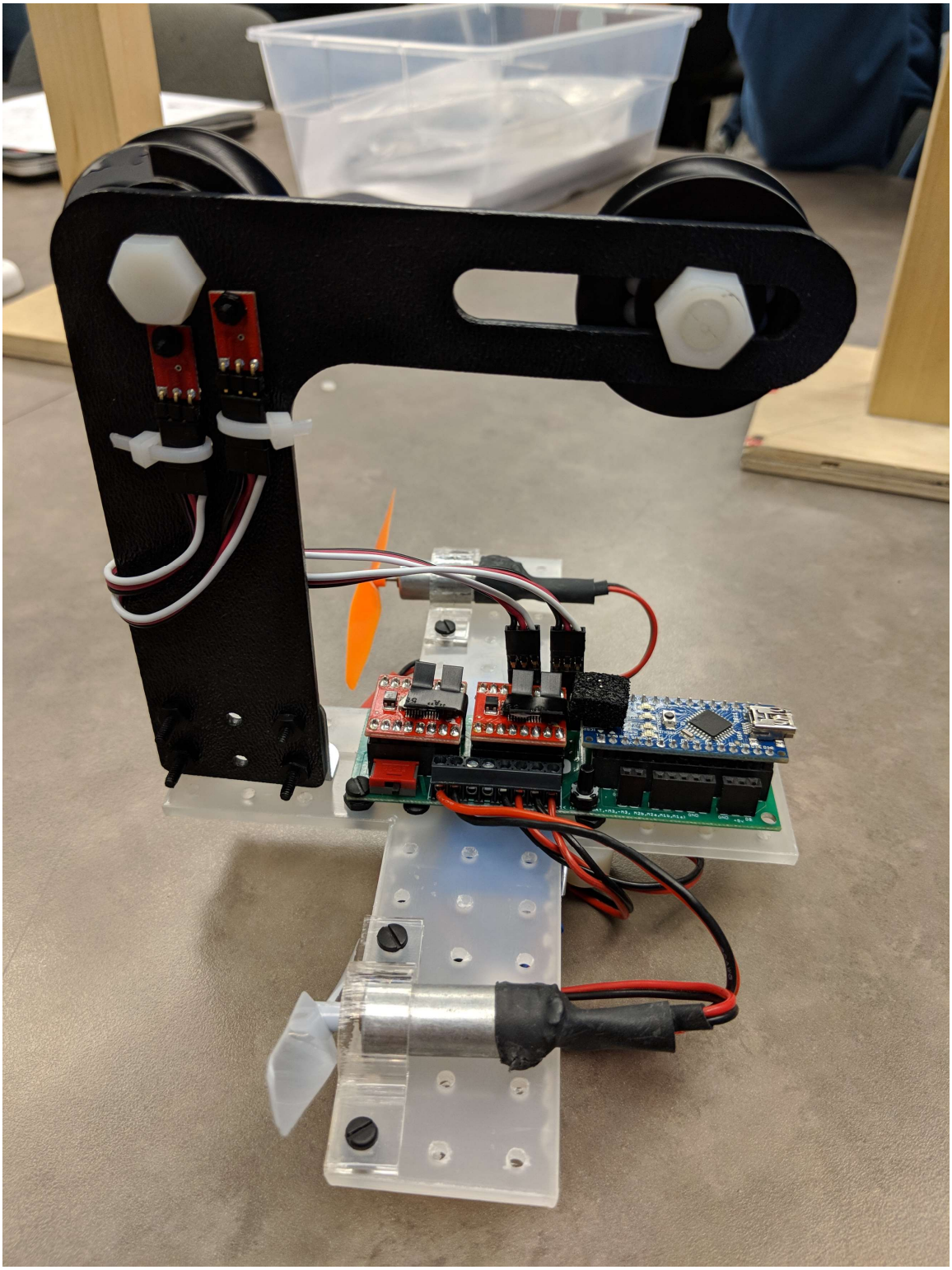
UPDATED

```
//Motor configuration programming
 //2-20-18

 //check first motor functionality
 celerate(1,0,35,3);
 goFor(3);
 brake(1);
 reverse(1);
 motorSpeed(1,35);
 goFor(3);
 celerate(1,35,0,1);
 brake(1);

 //check second motor functionality
 celerate(2,0,35,3);
 goFor(3);
 brake(2);
 reverse(2);
 motorSpeed(2,35);
 goFor(3);
 celerate(2,35,0,1);
 brake(2);

 //check both motors functionality
 celerate(4,0,35,3);
 goFor(3);
 brake(4);
 reverse(4);
 motorSpeed(4,35);
 goFor(3);
 celerate(4,35,0,1);
 brake(4);
```

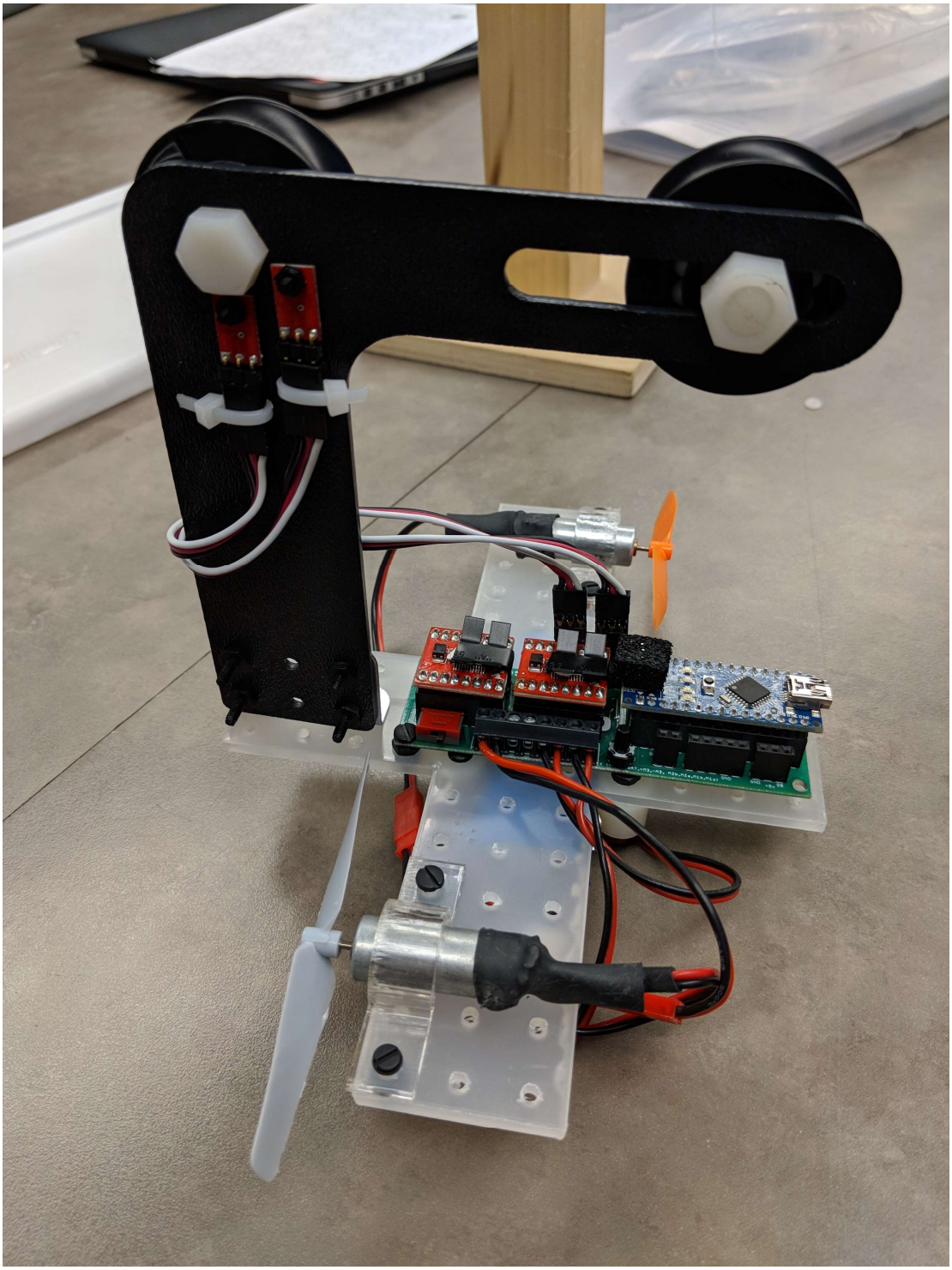
Additional Requirements:

AEV MOTOR CONFIGURATIONS

1:



2:



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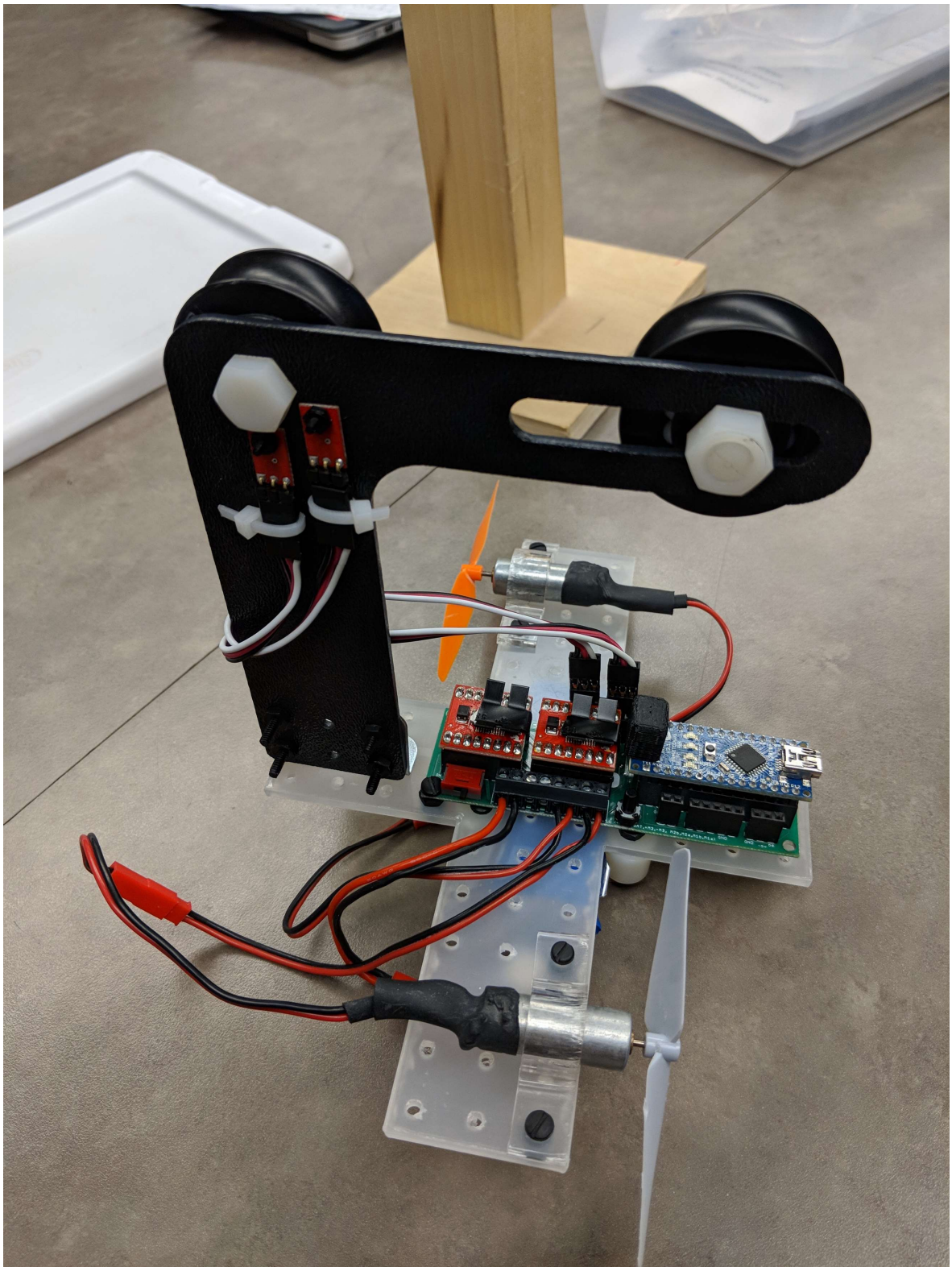

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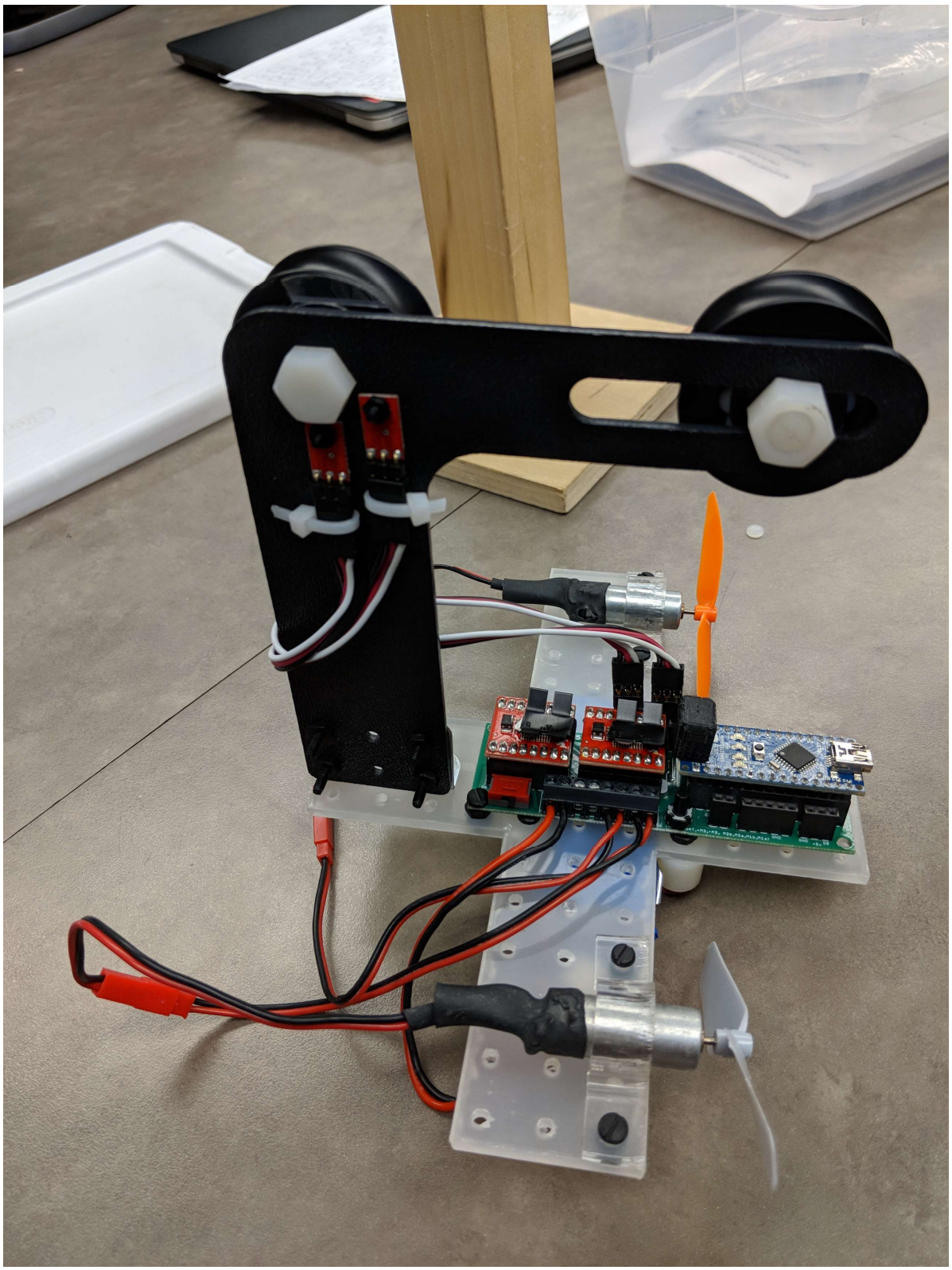
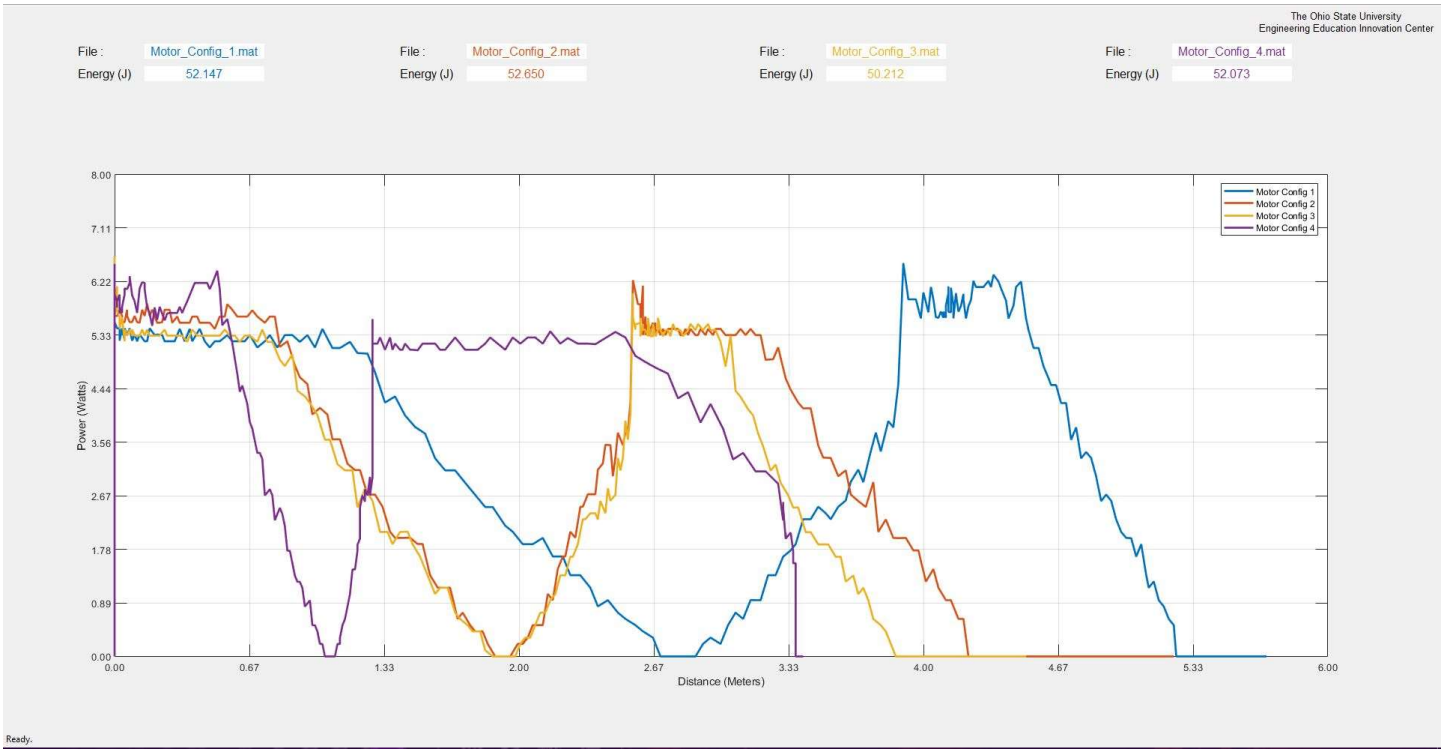
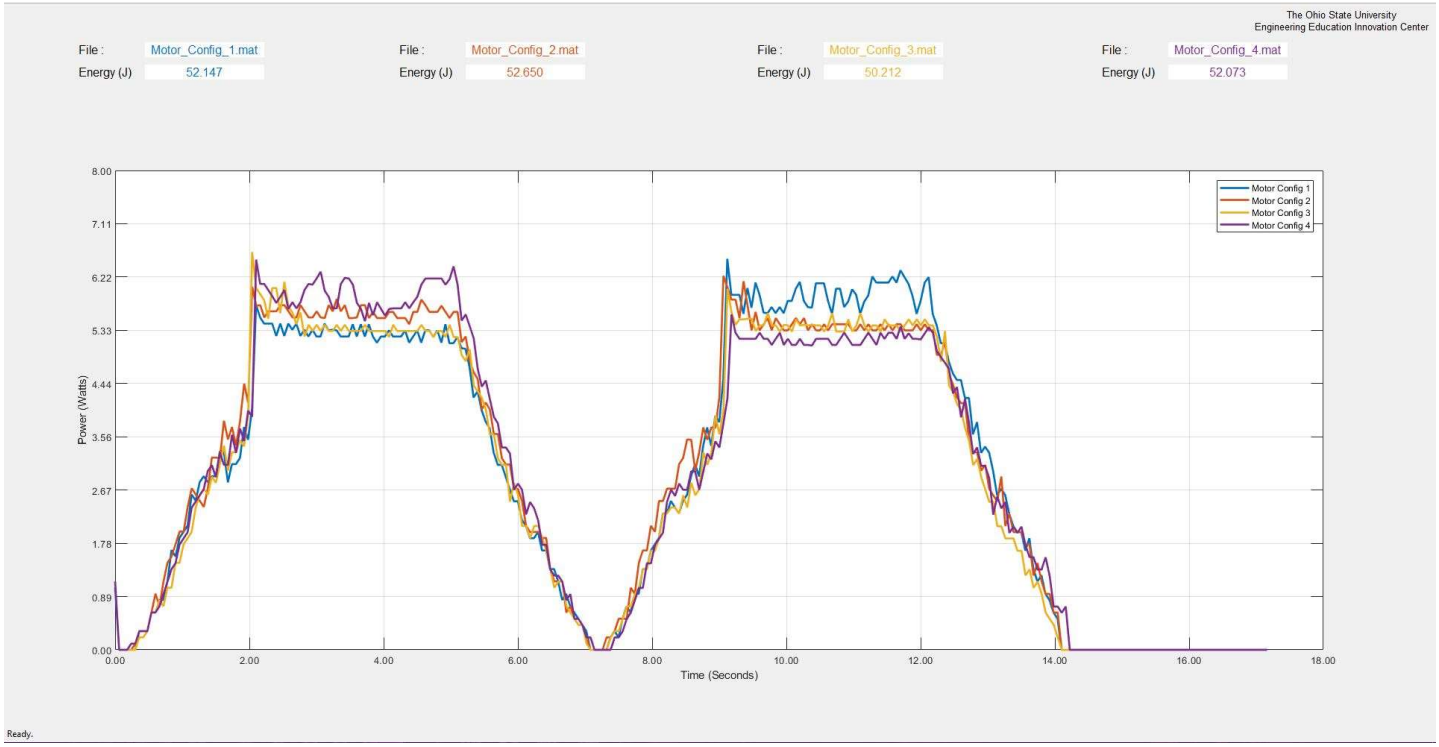


MOTOR CONFIGURATION RESULTS GRAPHS

1: Power v. Distance

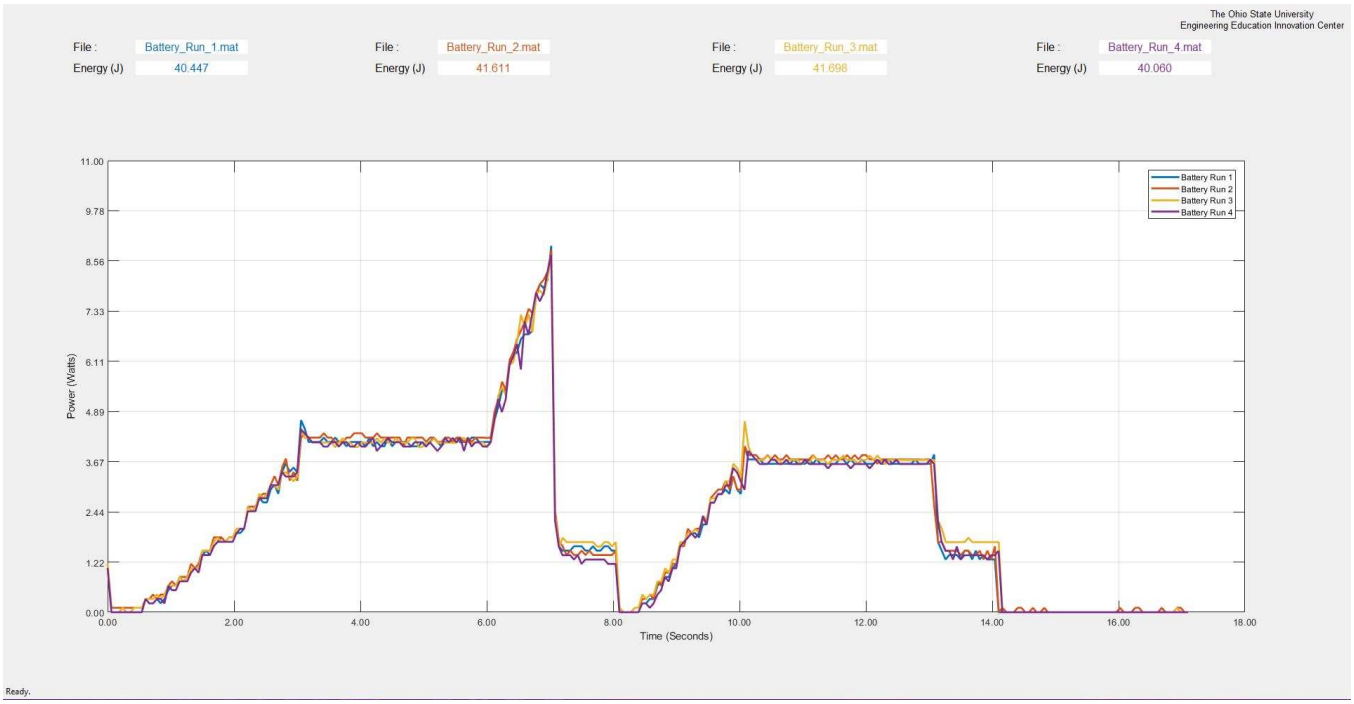


2: Power v. Time

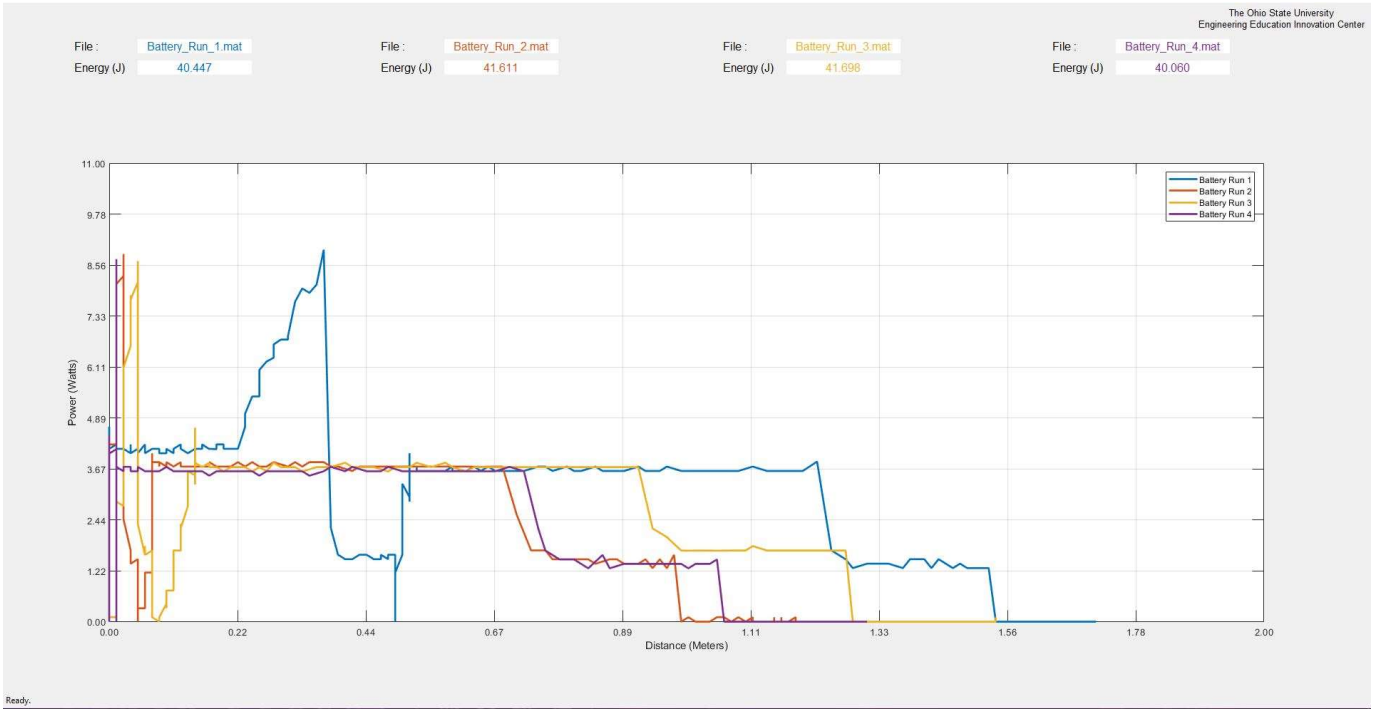


BATTERY TESTING RESULTS

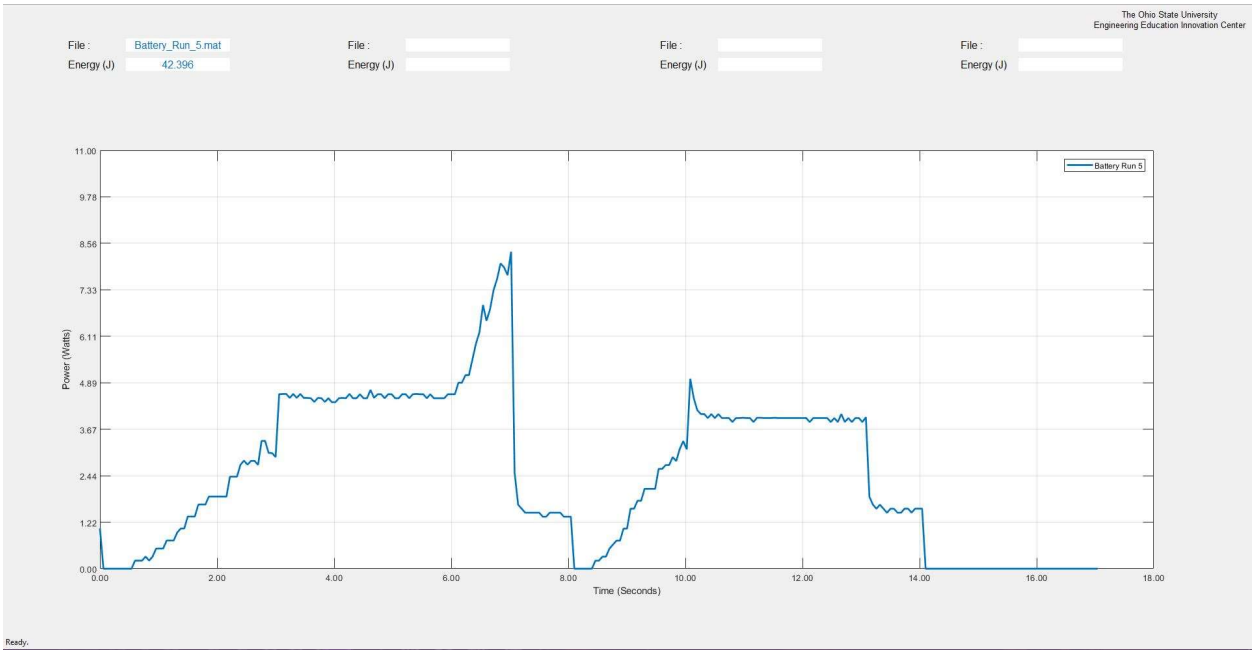
1: Battery Test 1-4, Power v. Time



2: Battery Test 1-4, Power v. Distance



3: Battery Test 5, Power v. Time



4: Batter Test 5, Power v. Distance