Thomas O’neill;Raymond Klouda;William Pisani;Christian Gaya;Christopher Fishman

FAMU-FSU College of Engineering  2525 Pottsdamer St. Tallahassee, FL. 32310

Team 505: SAE Hybrid Vehicle Battery Box and BMS

9/18/2018



# Abstract

The abstract is a concise statement of the significant contents of your project. The abstract should be one paragraph of between 150 and 500 words. The abstract is not indents.

*Keywords*: list 3 to 5 keywords that describe your project.

# Disclaimer

Your sponsor may require a disclaimer on the report. Especially if it is a government sponsored project or confidential project. If a disclaimer is not required delete this section.

# Acknowledgement

These remarks thanks those that helped you complete your senior design project. Especially those who have sponsored the project, provided mentorship advice, and materials. 4

* Paragraph 1 thank sponsor!
* Paragraph 2 thank advisors.
* Paragraph 3 thank those that provided you materials and resources.
* Paragraph 4 thank anyone else who helped you.

Table of Contents

[Abstract ii](#_Toc490488609)

[Disclaimer iii](#_Toc490488610)

[Acknowledgement iv](#_Toc490488611)

[List of Tables vii](#_Toc490488612)

[List of Figures viii](#_Toc490488613)

[Notation ix](#_Toc490488614)

[Chapter One: EML 4551C 1](#_Toc490488615)

[1.1 Project Scope 1](#_Toc490488616)

[1.2 Customer Needs 1](#_Toc490488617)

[1.3 Functional Decomposition 1](#_Toc490488618)

[1.4 Target Summary 1](#_Toc490488619)

[1.5 Concept Generation 1](#_Toc490488620)

[Concept 1. 1](#_Toc490488621)

[Concept 2. 1](#_Toc490488622)

[Concept 3. 1](#_Toc490488623)

[Concept 4. 1](#_Toc490488624)

[Concept n+1. 1](#_Toc490488625)

[1.6 Concept Selection 2](#_Toc490488626)

[1.8 Spring Project Plan 2](#_Toc490488627)

[Chapter Two: EML 4552C 3](#_Toc490488628)

[2.1 Spring Plan 3](#_Toc490488629)

[Project Plan. 3](#_Toc490488630)

[Build Plan. 3](#_Toc490488631)

[Appendices 4](#_Toc490488632)

[Appendix A: Code of Conduct 6](#_Toc490488633)

[Appendix B: Functional Decomposition 7](#_Toc490488634)

[Appendix C: Target Catalog 8](#_Toc490488635)

[Appendix A: APA Headings (delete) 8](#_Toc490488636)

[Heading 1 is Centered, Boldface, Uppercase and Lowercase Heading 8](#_Toc490488637)

[Heading 2 is Flush Left, Boldface, Uppercase and Lowercase Heading 8](#_Toc490488638)

[Heading 3 is indented, boldface lowercase paragraph heading ending with a period. 8](#_Toc490488639)

[Appendix B Figures and Tables (delete) 9](#_Toc490488640)

[Flush Left, Boldface, Uppercase and Lowercase 10](#_Toc490488641)

[References 11](#_Toc490488642)

# List of Tables

[Table 1 *The Word Table and the Table Number are Normal Font and Flush Left. The Caption is Flush Left, Italicized, Uppercase and Lowercase* 10](#_Toc490488643)

# List of Figures

[Figure 1. Flush left, normal font settings, sentence case, and ends with a period. 9](#_Toc490488644)

# Notation

|  |  |
| --- | --- |
| A17 | Steering Column Angle |
| A27 | Pan Angle |
| A40 | Back Angle |
| A42 | Hip Angle |
| AAA | American Automobile Association |
| AARP | American Association of Retired Persons |
| AHP | Accelerator Heel Point |
| ANOVA | Analysis of Variance |
| AOTA | American Occupational Therapy Association |
| ASA | American Society on Aging |
| BA | Back Angle |
| BOF | Ball of Foot |
| BOFRP | Ball of Foot Reference Point |
| CAD | Computer Aided Design |
| CDC | Centers for Disease Control and Prevention |
| CU-ICAR | Clemson University - International Center for Automotive Research |
| DDI | Driver Death per Involvement Ratio |
| DIT | Driver Involvement per Vehicle Mile Traveled |
| Difference | Difference between the calculated and measured BOFRP to H-point |
| DRR | Death Rate Ratio |
| DRS | Driving Rehabilitation Specialist |
| EMM | Estimated Marginal Means |
| FARS | Fatality Analysis Reporting System |
| FMVSS | Federal Motor Vehicle Safety Standard |
| GES | General Estimates System |
| GHS | Greenville Health System |
| H13 | Steering Wheel Thigh Clearance |
| H17 | Wheel Center to Heel Pont |
| H30 | H-point to accelerator heel point |
| HPD | H-point Design Tool |
| HPM | H-point Machine |
| HPM-II | H-point Machine II |
| HT | H-point Travel |
| HX | H-point to Accelerator Heel Point |
| HZ | H-point to Accelerator Heel Point |
| IIHS | Insurance Institute for Highway Safety |
| L6 | BFRP to Steering Wheel Center |
|  |  |
|  |  |
|  |  |

# Chapter One: EML 4551C

## Project Scope

Project Description: We will create a battery container that will be based off the FAMU - FSU Society of Automotive Engineers (SAE) hybrid vehicle competition team’s current vehicle design idea. A management system will also be created for the team to manage the hybrid battery to be used in the vehicle.

Key Goals: The battery container will be compact and will be able to fit onto the hybrid vehicle designed by the FAMU - FSU SAE team. The pack will also be environmentally sustainable. The container will be waterproof. Because of battery creating heat in an enclosed volume, it will be thermally insulated. The battery management system will be developed to maintain charge control and cell balancing of the battery in a safe and efficient manner while also monitoring power input and output.

Markets: The main market that will be targeted for this project is the FAMU FSU SAE hybrid vehicle competition team since the battery box and battery management system will be created for their existing vehicle ideas. Secondary markets include any hybrid vehicle manufacturers and any vehicle consumers interested in hybrid batteries.

Assumptions: For this project, some assumptions had to be made before beginning the designs of the battery box and the battery management system. These assumptions include that the energy storage systems will work, the energy storage systems will be battery powered, and the battery will be safely contained within the battery box.

Stakeholders: The stakeholders that are taking part in this project are Cummins, SAE, Dr. Hays, Dr. Oates, Dr. McConomy, and Dr. Hooker.

## Customer Needs

Our team conducted various meetings with our advisor, Dr. Oates, our sponsor, Dr. Hays, Dr. McConomy, and Dr. Moss. Through these meetings, multiple questions were asked and the answers were recorded for each question. The answers correspond to the customer statements below. From the customer statements, our team took an engineering approach and interpreted each statement into a need for the project. These interpreted needs can be seen below in the table.

|  |  |  |
| --- | --- | --- |
| Question/Prompt | Customer Statement | Interpreted Need |
| Should we build a battery box specific to the current SAE hybrid vehicle? | I want to be able to provide parameters about the battery that the box is holding and get values returned about the size of the box. | Design a program that takes parameters, and outputs properly scaled dimensions. |
| Should a physical model of the battery box be built? | The main item I'm looking for is the program that will give me values based on the battery. | Focus primarily on building a management program. |
| What should the battery box protect from? | The container will be waterproof, thermally insulated, and environmentally sustainable. | The battery box protects the battery, prevents overheating, and avoids environmental impact. |
| What should the BMS do? | The BMS should maintain charge control and cell balancing of the battery in a safe and efficient manner while also monitoring power input and output. | BMS maintains charge control, cell balancing, and monitors power input and output. |
| What battery configuration are we using to create a BMS for? | Decide on a series or parallel battery pack. Whichever works best for the motor that is being used in the vehicle. | Use desired toque output to size the motor and therefore determine the battery configuration. |
| Should we investigate building our own battery or buying one off the shelf? | Creating your own battery would be very difficult. I recommend buying one off the shelf and using that to create a BMS. | Select existing battery that meets requirements of drivetrain. |
| Do you think there are any restrictions to the battery box and BMS? | The SAE rulebook for the competition should contain all details about how the vehicles must be built. | The battery box and BMS both adhere to SAE competition guidelines. |

## 1.3 Functional Decomposition

## 1.4 Target Summary

## 1.5 Concept Generation

### Concept 1.

### Concept 2.

### Concept 3.

### Concept 4.

### Concept n+1.

## 1.6 Concept Selection

## 1.8 Spring Project Plan

# Chapter Two: EML 4552C

## 2.1 Spring Plan

### Project Plan.

### Build Plan.

# Appendices

# Appendix A: Code of Conduct

**FAMU/FSU College of Engineering**

**Department of Electrical and Computer Engineering**

**Code of Conduct**

**SAE Hybrid Vehicle and BMS**

Thomas O’neill tao16my.fsu.edu

William Pisani wjp15b@my.fsu.edu

Raymond Klouda rjk15b@my.fsu.edu

Christopher Fishman cjf13e@my.fsu.edu

Christian Gaya cpg14@my.fsu.edu

**Date 9/6/2018**

**Mission Statement**

Every member of team 505 will fully contribute to every aspect of the project from start to finish. Every team member’s efforts will be the best they can provide. Work environments should be positive, comfortable, and fully allow each member to complete their assigned tasks without ridicule. Only with true respect, integrity, and professionalism will the final product meet expectations.

**Team Roles**

Each team member is delegated a specific role based on their experience and skill sets and is responsible for all here-within:

**Team Leader** – **Thomas O’Neill**

The team leader will handle the majority of task assignments, scheduling, and will maintain sufficient contact with sponsors, advisors, and team members. Though all members may work on documents, team leader will ensure documentation of each event or correspondence throughout the project. This documentation and any other documents throughout the project will be finished and finalized by the team leader.

Team leader will ensure the ship sails smoothly throughout the project. If a problem is to arise, the team leader will ensure the project stays on task and prevent further development of the problem. Communication will be done by team leader in a timely fashion and whenever deemed necessary by sponsor, advisor, or another member. The team leader may assign certain contact to other members or allow other members to choose to be line of contact when deemed necessary. Organization of in-person meetings will be done by the team leader. This includes a weekly agenda, organization of meeting times, and management of team calendar.

**Team members:**

**Financial Advisor: Christopher Fishman**

The financial advisor will maintain all group finances throughout the project. Any purchase requests must be done through this advisor. The advisor will ensure allocation of funds when necessary and will provide a running total of team balances weekly. The advisor will keep all receipts and invoices as documentation and will also ensure documentation of conversation between team members.

**Battery Box Design Lead Engineer: Thomas O’Neill**

Takes charge of Mechanical design aspects of the project. Keeps line of communication with the Electrical team. Lead Mechanical is responsible for knowing details of the battery box design, and for presenting the options for each aspect to the team for the decision process. Keeps all design documentation for record and is responsible for gathering all reports.

**Battery Box Coolant Design Engineer: William Pisani**

Works with the battery box design lead engineer and the battery box crash resistance design engineer to create a finalized battery box. Will oversee the battery coolant system that will maintain parameters conductive to the batteries heath. These parameters will be established in conjunction with the battery box lead engineer, our team sponsor, and the battery coolant design engineer. These specifications will also be dependent on the battery decided for purchase. The cost of this system will be specified, again, in conjunction with the sponsor and lead battery box engineer.

**Battery Box Crash Resistance Engineer: Raymond Klouda**

Works with the battery box design lead engineer and the battery box coolant design engineer to create a battery box. Assists in the design of the battery box by calculating for the forces related to any impact that the battery box may see. The crash resistant engineer will also determine the overall longevity and life span that the physical battery box may have after being equipped in a vehicle.

**Battery Management System: Christian Gaya**

Lead Electrical and Computer is responsible of the Electrical and Computer design parts in support of the project. Lead Electrical and Computer maintains line of communication with the lead Mechanical and keeps all Electrical design documentation as record.

**All Team Members (Other Duties):**

Should a task require completion that is not expressly assigned to a team member, the team will decide as a group on how to distribute the additional tasks. The team leader will have the ability to veto the group and assign the tasks to whom they see fit if an agreement cannot be reached.

**Communication**

The primary line of communication between team members will be through Discord. Other methods such as GroupMe, Skype, text, or phone call will be used if needed or preferred at the time.

Scheduling will be done mainly through the group’s online calendar. It will contain known events that take place for each team member which prevent their ability to meet and work on the project. Classes, work, meetings outside of the project, extracurriculars, and personal events should always be listed on the calendar in advance to allow the team to operate smoothly. Meeting times will be chosen based off the calendar times slots available to all members weekly. Should a time conflict arise, the team leader will notify the group of the conflict and attempt to reschedule the team event for another time that agrees with all member’s schedules.

Response delays from team members, sponsors, advisors, etc. are to be expected. When these occur, the team shall be updated with the latest information (even in the event of a no-response situation). For internal team talk, a 12-hour response delay is acceptable for any reason preventing immediate communication. Team members should still communicate as soon as they are able and not at the end of the given 12-hour window. All correspondence with persons outside of the immediate team shall be answered no later than 24 hours after receipt of original message.

**Dress Code**

Dress code for team meetings will be casual. Team members will not be expected to wear any kind of dress code during weekly scheduled meetings. For presentations, business casual attire is acceptable for all team members. For all sponsor and professional interactions, full formal business attire will be required (suit and tie). If suggested, the tram may be expected to wear a more formal attire during events where it would otherwise not be required.

**Attendance**

Attendance to team events is required by all team members. Attendance will be kept on the meeting documentation for each event before the agenda begins. This may be done electronically or by hand but will be contained in the project documentation. Attendance will be managed and reviewed periodically by team leader to ensure the attendance of all members. Team members will be notified if they are in violation of any policy. If the team comes to an agreement that a member has not been attending meetings regularly, an external source, Dr. McConomy, will be notified about that team members absence.

**Ethics**

Team members are required to be familiar with the NSPE Engineering Code of ethics as they are responsible for their obligations to the public, the client, the employer, and the profession.  There will be stringent following of the NSPE Engineering Code of Ethics.

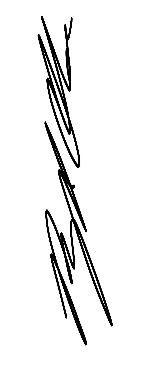
**Weekly and biweekly Tasks**

Team members will participate in all meetings with the sponsor, adviser and instructor. During said times ideas, project progress, budget, conflicts, timelines and due dates will be discussed. In addition, tasks will be delegated to team members during these meetings. Repeat absences will not be tolerated.

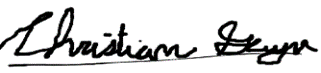
**Statement of Understanding**

By signing this document, the members of Team 505 agree the all the above and will abide by the code of conduct set forth by the group.

Name                                                     Signature                                   Date

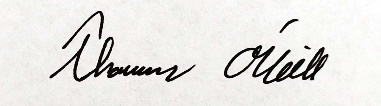
https://lh5.googleusercontent.com/RKqgxl3Ubt0BDqPiTgs7fsHq94B5ScUTz2auix7Q4CXsykMivU619fMnxQYQeVEWHj8W9MVRbrm6I5qd76rDzwKoM60MtP_8wTruRlFXX4MhQMHYaNtYSdlQoqC3P2DNhSDzOWBa

­­­­­­­­­­­­­­­Christopher Fishman 9/18/18



Christian Gaya 9/18/18

Raymond Klouda 9/18/18



Thomas O’Neal 9/18/18



William Pisani 9/18/18

# Appendix B: Functional Decomposition

# Appendix C: Target Catalog

# Appendix A: APA Headings (delete)

# Heading 1 is Centered, Boldface, Uppercase and Lowercase Heading

## Heading 2 is Flush Left, Boldface, Uppercase and Lowercase Heading

### Heading 3 is indented, boldface lowercase paragraph heading ending with a period.

#### Heading 4 is indented, boldface, italicized, lowercase paragraph heading ending with a period.

##### Heading 5 is indented, italicized, lowercase paragraph heading ending with a period.

See publication manual of the American Psychological Association page 62

# Appendix B Figures and Tables (delete)

The text above the cation always introduces the reference material such as a figure or table. You should never show reference material then present the discussion. You can split the discussion around the reference material, but you should always introduce the reference material in your text first then show the information. If you look at the Figure 1 below the caption has a period after the figure number and is left justified whereas the figure itself is centered.



Figure 1. Flush left, normal font settings, sentence case, and ends with a period.

In addition, table captions are placed above the table and have a return after the table number. The second line of the caption provided the description. Note, there is a difference between a return and enter. A return is accomplished with the shortcut key shift + enter. Last, unlike the caption for a figure, a table caption does not end with a period, nor is there a period after the table number.

Table 1  
*The Word Table and the Table Number are Normal Font and Flush Left. The Caption is Flush Left, Italicized, Uppercase and Lowercase*

|  |  |
| --- | --- |
| Level of heading | Format |
| 1 | **Centered, Boldface, Uppercase and Lowercase Heading** |
| 2 | Flush Left, Boldface, Uppercase and Lowercase |
| 3 | Indented, boldface lowercase paragraph heading ending with a period |
| 4 | Indented, boldface, italicized, lowercase paragraph heading ending with a period. |
| 5 | Indented, italicized, lowercase paragraph heading ending with a period. |

# References

**There are no sources in the current document.**