



## AM-BATS part deux

### Advanced Modular Battery System

#### ELECOMP Capstone Design Project 2021-2022

*This project is the continuation of last year's project. The results achieved were presented at the Virtual Summit on May 7<sup>th</sup>, 2021.*

<https://web.uri.edu/elecomp-capstone/project-details-by-team/eaglepicher-am-bats/>

#### Sponsoring Company:

##### EaglePicher Technologies

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<https://www.eaglepicher.com/>

#### Company Overview:

EaglePicher Technologies is a leading producer of batteries and energetic devices. For more than 75 years, we have been serving the mission-critical aerospace, defense, aviation, and medical battery markets. EaglePicher's batteries are a key component of the U.S. space program; our batteries provided the emergency power that successfully brought the Apollo 13 crew home. Today, EaglePicher batteries power the International Space Station, Mars Rovers, commercial jets and helicopters, life-saving medical implants and more than 85 percent of U.S. missile platforms.



## Technical Directors:

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## Project Motivation :

EaglePicher specializes in providing battery solutions for very demanding applications. Our batteries are frequently required to perform at extremes in temperature, vibrations, power delivery and service life. These are not your cordless drill batteries. Some of our batteries are currently on Mars and delivering cutting edge performance as you read this. Achieving the performance that our customers demand requires advancements in the tools and methods used to evaluate battery cell designs, integrated with the battery management systems to control them. Tradeoffs typical in BMS product designs create limitations that make laboratory instrumentation challenging. A battery management system with the ability to collect high fidelity performance telemetry could prove invaluable in evaluating battery cell designs. Illuminating the unique characteristics of candidate battery cells will aid in establishing the minimum requirements for a deliverable BMS design. Ultimately, a better understanding of cell characteristics, and how those characteristics can be observed and interpreted by the BMS, is the next step in optimizing the use of the batteries in both first and second life applications.



## Anticipated Best Outcome:

- A) Design and build a Battery Management System platform for investigating battery cell performance for demanding applications. This will include the ability to synthesize the charge and load characteristics for a variety of applications.
- B) Using the AMBATS platform, demonstrate the safety protocols and performance of Li-Ion batteries in various applications. EaglePicher will provide usage profiles ranging from electric bikes, to vehicles, to directed energy weapons and hybrid load conditioners.
- C) Identify the correlation between BMS measurements and the prediction of aging for various cells and usage profiles.

## Project Details:

The objective of this project is to design an investigational platform that integrates a battery management system with high fidelity data collection capabilities. EaglePicher Technologies develops Lilon battery cells with a wide range of characteristics. The successful outcome of this project will facilitate the characterization of these battery cells in concert with the battery management functions necessary to protect the cells and the application for which they are intended, from catastrophic failure. The envisioned outcome will feature a functional hardware and software platform capable of monitoring a fixed number of battery cells (e.g.: 4-12) while providing well correlated telemetry data for analysis.

## Hardware/Electrical Tasks:

1. Along with the CPE team, draft a requirements specification for an investigational BMS platform to evaluate high performance battery cells.
2. Evaluate and Propose design concepts in accordance with the specification document.
3. Create a preliminary design based on the selected concept. Present a block diagram design and description for review and approval
4. Perform a detailed design of the BMS electronics with a detailed hardware design description and supporting analysis.
5. Present the BMS design for critical review with EaglePicher support
6. Build and test a Proto-Type of the proposed design
7. Perform validation and benchmark testing to qualify the design meets the requirements in collaboration with the CPE team. Note: EP will provide fresh and aged battery packs including appropriate usage profiles. EP will also work with the AMBATS team to ensure that safe charge and load parameters are selected.
8. Present findings



### **Firmware/Software/Computer Tasks:**

1. Draft a software requirements specification for an investigational BMS platform to evaluate high performance battery cells.
2. Collaborate with the electrical team in proposing and evaluating design proposals to meet the requirements
3. Generate a Software Requirements Specification based on the selected proposal for review and approval
4. Develop a Software Design Description based on the detailed hardware design
5. Present the SDD for critical review with EaglePicher support
6. Develop functional software in accordance with the SDD
7. Test and validate the operational software on the target BMS
9. Stretch Goal: Use the data from #7 to develop algorithms that accurately predict the effects of usage on aging.

Present findings

### **Composition of the Team:**

1-2 Electrical Engineers & 1-2 Computer Engineers.

**US Citizenship Required; Background Checks will also be conducted before the first kick-off meeting with the Technical Director.**

### **Skills Required:**

#### **Electrical Engineering Skills Required:**

- Organization and Documentation
- Circuit simulation
- Electrical Safety knowledge and awareness
- Analog circuit design
- Digital circuit design
- Power circuit design
- Knowledge and use of common lab equipment
- PCB layout
- Soldering, Troubleshooting, Repair



**Computer Engineering Skills Required:**

- Organization and Documentation
- Embedded software development
- User interface design
- IDEs / Debuggers
- Algorithm development
- Analog Signal processing
- Digital Signal processing and Filters
- Test, Debug and Validate code

**Anticipated Best Outcome's Impact on Company's Business, and Economic Impact**

If successful, this project will accelerate the evaluation and validation of next generation EaglePicher Technology battery cells and systems for demanding applications.

**Broader Implications of the Best Outcome on the Company's Industry:**

This project creates an efficient and robust process in developing reliable high-performance battery management systems. By optimizing the BMS around the most important parameters to measure, for both safety and state of health/charge, EaglePicher Technologies will set the standard for providing rapid solutions for critical applications.