INDUSTRIAL SOLUTIONS LABORATORY

Company Information

Company Name	*Belmont Trolley, Inc.*	**Date Submitted**	*04/28/2022*
Project Title	*Trolley Battery Cart HMI and Control Upgrade* **(TROLLEY_BATT2)**	**Planned Starting Semester**	*Fall 2022*

Senior Design Project Description

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills.

Discipline	Number	Discipline	Number
Mechanical	3	Electrical	2
Computer		Systems	

Company and Project Overview:

In 1911 leaders at Southern Power Company, William States Lee and James Buchanan "Buck" Duke, built the Piedmont and Northern Railway (P&N), an electrically-powered, interurban rail system linking major cities across the Piedmont of the Carolinas. The arrival of the railway created unprecedented growth in North Carolina's textile industry.

One of P&N's busy divisions ran 24 miles between Charlotte and Gastonia, NC. In 1916, at the request of Belmont's booming textile mills, P&N added a three-mile route from its main line near the city of Mount Holly to downtown Belmont. Along these tracks, three small, city-style trolley cars carried passengers and workers between the mills and the main line.

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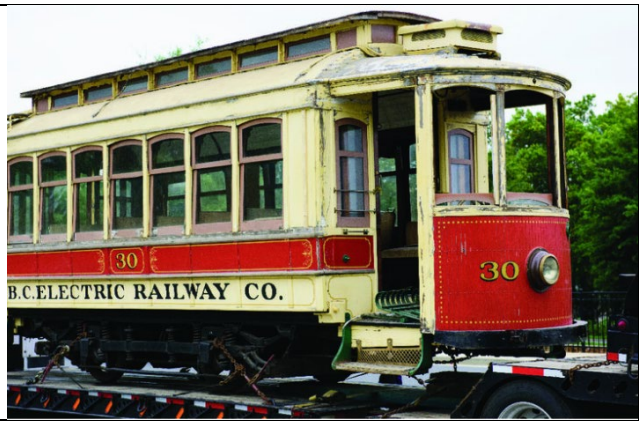

Although P&N continued its freight service in the region until the late 1960s, Belmont's streetcar service ended in 1932. When complete, the historic Trolley will run from downtown Belmont, N.C., to Belmont Abbey College, shuttling up to 20 commuters, residents and visitors at a leisurely pace. The line will run parallel to the Belmont Rail Trail, a greenway following the path of the Carolina Thread Trail through Belmont.
Trolley Car 30 was built in 1912 by J.G. Brill Company, the Trolley was shipped from Porto, Portugal, where it ran faithfully until the 1980s. In the 1990s, Car 30 returned to the U.S. to launch a trolley project near Portland, Oregon. But the project never materialized and the car sat idle until it was acquired by Fraser Valley Heritage Railway Society in Surrey, British Columbia, Canada. Fraser Valley had the Trolley for 10 years before deciding to sell it. Through a tip from a friend, the Belmont Trolley organization made the purchase and arranged for Car 30's long transport from Surrey to Belmont. Here, the renovated Trolley will embark on a new journey of service.

Project Requirements:

Belmont Trolley sponsored a Senior Design project for the 2021/2022 academic year to develop a battery cart generator using EV batteries to provide 600Vdc to power our trolleys. As part of this design, the student team installed an AC motor to move the cart, onboard battery charger to charge the batteries, and a set of manual switches, contactors and indicators to control the charging, propulsion (cart moving), and DC output power to the trolleys.

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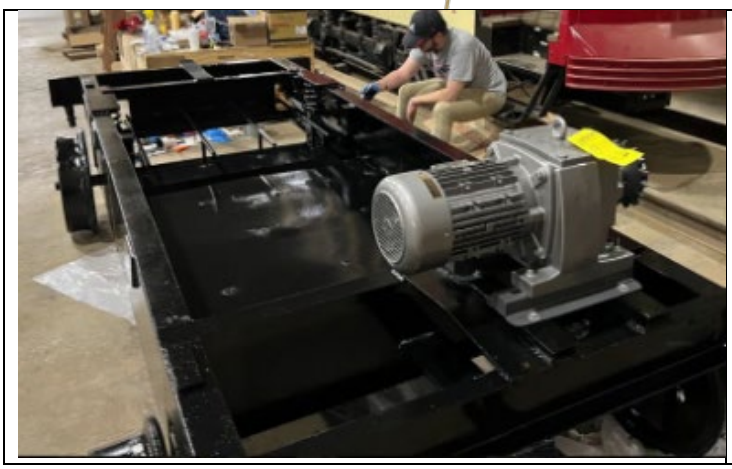

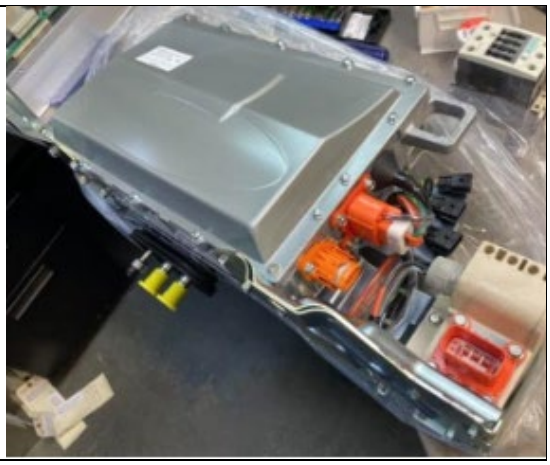

We'd like to update these controls with an HMI to be able to monitor the CAN communications on the charger, Battery Management System, control features (cart propulsion, charging cycle, trolley DC output, etc.) and potentially a PLC rack to control the contactors on the system in place of static switches. We would also like some wireless communications for some of these control features and remote monitoring of the battery charging cycle.

On the mechanical side, Belmont Trolley would like to design a removal shell for our cart that is sleek and modern, so as not to detract from the appearance of our historic trolleys, and protective of the internal electrical equipment. As part of the shell design, we would like some fire-suppression features, or recommendations for protocols) to follow and some accessibility, viewing, and ventilation features to protect and access the controls, internal electrical components, and observe the internal features of cart for aesthetics (coolness) and safety reasons (identify fires or other failures visually).

Expected Deliverables/Results:

- Touchscreen user interface to control and monitor all of the cart's functionality (battery cell health, battery state of charge, trolley output voltage, etc). This could be in the form of an integrated controller of PLC interfacing a display, etc.
- Remote control or Bluetooth app to control the cart movements (safety feature to create a buffer between operator and cart)
- Remote app or interface to monitor the cart battery charging systems and control the cart charging cycle (set desired charge level, walk away, and allow system charge, turn off, or shut down in case of fault without the need for in-person monitoring)
- "Future Proofing" the cart. Expandability so new features such as wireless charging or battery temperature monitoring, etc. can be installed on the cart.
- Installation of a more universal onboard charger that can be configured for various battery manufacturers or design of a custom charger that doesn't require the use of proprietary communications protocols.
- Protective cart shell, or design of shell that can be contracted for fabrication, as described in

previous segment.

Disposition of Deliverables at the End of the Project:

Students are graded based on their display and presentation of their team's work product. It is mandatory that they exhibit at the Expo, so if the work product was tested at the supporter's location, it must be returned to campus for the Expo. After the expo, the team and supporter should arrange the handover of the work product to the industry supporter. This handover must be concluded within 7 days of the Expo.

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):

- Programming with an understanding of CAN communications
- Knowledge of LabView would be preferable since Belmont Trolley's project lead and liaison has experience with this program.
- Instrumentation
- Basic electrical theory and design