

Reflection Report on MECHTRON 4TB6

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1 Changes in Response to Feedback

1.1 SRS and Hazard Analysis

1.2 Design and Design Documentation

1.3 VnV Plan and Report

2 Design Iteration (LO11)

2.1 Printed Circuit Board Design

Robust electrical connections between the electronic components of the device were a major point of focus for our project. The main electronics requiring robust power and signal electrical connections were the Arduino (microcontroller), ESP8266 (Wi-Fi module), and micro-SD card (local memory storage).

The first iteration in electrical connections occurred between the Proof of Concept and Revision 0 Demonstrations through the transition from a breadboard and jumper wire electrical implementation to a custom design PCB. The power and signal connections made on the breadboard were translated onto an electrical schematic in KiCad, a schematic capture and PCB design software. The PCB layout and trace routes were then created using the schematic to complete the PCB design.

The second iteration in electrical connections occurred between the Revision 0 and Revision 1 Demonstrations through the transition from a custom design PCB to a custom design PCB with a smaller form factor. The second custom PCB design achieved a reduction in board size by 53% from 151 mm x 112 mm down to 97 mm x 81 mm. The use of both planes of the PCB to solder the electronic components was the primary driver in area reduction from Revision 0, which required all electronic components to solder onto the same plane.

2.2 Chassis Design

2.3 Sensor Configuration Interface

2.4 Data Visualization Page

3 Design Decisions (LO12)

3.1 Custom Printed Circuit Board

The choice to design a custom PCB to interconnect all electrical components was driven by a PCB's ability to maintain electrical connectivity in high vibration environments. Particularly in McMaster Formula Electric's application as a vehicle driving on top of a road, the device was expected to maintain functionality in high vibration environments such as high vibrations due to rough road surfaces.

Furthermore, PCB's provided a space effective solution to electrical connections relative to jumper wires connected to a breadboard circuit because of the planar copper connections between components. As a result, the overall height required by the electrical circuit was minimized using a 2-layer PCB. The PCB's permanent connections were also desirable for power and signal connections between the Arduino, local memory module, Wi-Fi module, and terminal blocks because those component and their respective connections were always the same irrespective of the test setup.

3.2 3D Printed Chassis

3.3 Code that Writes Code

3.4 Data Visualization Page

4 Economic Considerations (LO23)

Formulate is an open source product for any University's Formula team. Our public GitHub repository allows teams to freely download the Gerber files to manufacture the PCB, chassis CAD model to 3D print the enclosure, executable to run the user interface, and PBIX file for the data visualization template.

The market for Formulate is sizeable, with over 600 Formula series teams (combustion, hybrid, and electric) active across more than 20 countries, with 75 of those teams competing in the Formula Electric competition in the 2023 North American series alone.

Our team plans to create a promotional video on social media platforms such as LinkedIn to attract the attention of the global market of Universities who

compete in the Formula Electric competition. Even within the Formula Electric team at McMaster, we aim to attract the attention of members through testing sessions with the product to increase product exposure and educating interested members on the benefit of the product.

The overall capital expenditure (Capex) for teams to build a Formulate device was intentionally small to increase the product's economic viability for all Formula teams. The current cost to purchase the electrical and mechanical hardware using our open source build files is \$50 Canadian. The software cost for the user interface and the data visualization platform is \$0. Our team estimates the build time with the required hardware at hand to be 2 hours, assuming reasonable workmanship skills at a senior University student level.

5 Reflection on Project Management (LO24)

5.1 How Does Your Project Management Compare to Your Development Plan

5.2 What Went Well?

5.3 What Went Wrong?

5.4 What Would you Do Differently Next Time?