# Technical Discussion

In completing the design for the parts counter, the system meets all the design specifications introduced in the project proposal. First, the design is adjustable to all six different parts specified (refer requirement FR-1 in Appendix). The system physically as well as electronically adapts to each part by changing the plate and controlling the motor speed. Next, the system was designed in a self contained frame that is relatively portable and simple to configure (refer requirement AR-1 in Appendix). The components were packaged in a minimal form factor with minimal space reserved for maintenance access. The implemented system was capable of dispensing parts in varying amount up to 6 and cycling indefinitely (refer requirement FR-2 and CR-2 in Appendix). Through the HMI panel, the system meets the requirements of system adjustability by allow the user to change the number of parts to be dispensed per cycle (refer requirement FR-3 in Appendix). Additionally, the bowl design was tested to accommodate twice the quantity of parts needed to be processed at a time, satisfying the accommodation of size of parts requirement (refer requirement FR-1 and FR-7 in Appendix). The system was empirically tested through the competition and practice runs that the system has an average dispense time of less than 30 seconds while maintaining an accuracy of almost 100%, satisfying the dispense time requirement and accuracy requirement (refer requirement CR-1 and CR-3 in Appendix). The delivery mechanism was effectively designed to hold six of each part until the user dispenses the parts. Through a mechanical delivery system, the system dispenses the quantity of parts virtually instantaneously directly into the hand of the user. These features satisfy the delivery mechanism and method of parts storage requirements (refer requirement FR-5 and FR-6 in Appendix). As can be seen by these examples, the implemented system meets and in several cases exceeds the initial system requirements of the system.

The implementation of the system was not without challenges and hurdles during the integration phase of the system. Within the electromechanical assembly of the motor, motor shaft, and plate, the design experienced two specific failures. First, the mounting mechanism initially needed front face and rear mounting screws on the motor. When installing the read mounting screws on the motor, the motor experienced a mechanical defect in which the screws could be driven too far into the assembly. As a result, the screws cracked the brush of the motor when significant load torque was applied when testing the motor. To mitigate this problem, the rear screws were eliminated from the motor completely. In addition to the motor mounting issue, the shaft experienced a critical failure. When the shaft experienced significant loading in the case of the large bolts and nuts, the plastic corners on the hexagonal shaft stripped out completely. The shaft would spin without turning the plate causing the overall system to fail. To solve this problem, aluminum sheet metal was applied to three sides of the shaft to prevent the strip failure. After testing this solution the shaft no longer failed in this manner.

In addition to mechanical hurdles, the electrical integration experienced many roadblocks as well. First, the integration of the motor into the system interfered with the 5 volt bus. The pulse width modulated signal driving the motor caused noise spikes of greater than 5V to appear on the 5V regulated line. These spikes interfered with the operation of the sensors, causing false positives to occur. To mitigate this problem, a filtering capacitor was placed across the motor to smooth out the pulse width modulated signal. After installing the filter, the voltage on the 5V bus was measured through the oscilloscope and these spikes were reduced to less than 10mV, which would no longer interfere with the sensors. Lastly, after installing the sensor modules, one set of modules was demonstrated to intermittently fail. As a result, the count was completely inaccurate. The subsystem could not be fixed in hardware since the component was permanently fastened to the funnel. To eliminate this faulty sensor, the software was modified so that it would ignore the readings by the sensor module. Fortunately, the sensor design implemented redundant sensor modules, which allowed the failure of one sensor module to not impact the overall functionality of the system. By masking out the lower sensor module, the system returned to counting in its original, perfectly accurate state. As can be seen by these examples, the overall system integration phase was not without hiccups with the interaction between subsystems.