Modifying a commercial centrifuge to reduce electromagnetic interference and evaluating functionality of ultrasound equipment

The Project Management and Engineering Branch (SF4) supports the Human Health and Performance Directorate (HH&P) and is responsible for developing and supporting human systems hardware for the International Space Station (ISS). When a principal investigator's (PI) medical research project on the ISS is accepted, SF4 develops the necessary hardware and software to transport to the ISS. The two projects I primarily worked on were the centrifuge and ultrasound projects.

Centrifuge: One concern with spacecraft such as the ISS is electromagnetic interference (EMI) from onboard equipment, typically from radio waves (frequencies of ~3 kHz to ~300 GHz), which can negatively affect nearby circuitry. Standard commercial centrifuges produce EMI above safety limits, so my task was to help reduce EMI production from this equipment. Two centrifuges were tested: one unmodified as a control and one modified. To reduce EMI below safety limits, one centrifuge was modified to become a Faraday shield, in which significant electrical contact was made between all regions of the centrifuge housing. This included removing non-conductive paint, applying conductive fabric to the lid and foam sealer, adding a 10,000 µF decoupling capacitor across the power supply, and adding copper adhesive-mount gaskets to the housing interior. EMI testing of both centrifuges was performed in the EMI/EMC Control Test and Measurement Facility. EMI for both centrifuges was below safety limits for frequencies between 10 MHz and 15 GHz (pass); however, between 14 kHz and 10 MHz, EMI for the unmodified centrifuge exceeded safety limits (fail) as expected. Alternatively, for the modified centrifuge with the Faraday shield, EMI was below the safely limit of 55 dBµV/m for electromagnetic frequencies between 14 kHz and 10 MHz. This result indicates our modifications were successful. The successful EMI test allowed us to communicate with the vendor what modifications they needed to make to their commercial unit to meet our specifications and to understand what needs to be done in lab to the new centrifuge. Our modifications will provide a standard for readying centrifuges for future missions. Once the new modified centrifuge arrives by the vendor, it will need to undergo EMI testing again for validation. The centrifuge is also in the process of compatibility testing with a custom stowage drawer, which is an ongoing project in SF4. Both of these items will be payloads on future missions to the ISS for various research purposes.

Ultrasound: ISS currently has an onboard ultrasound (Ultrasound 2 system) for research and medical purposes. Every piece of medical flight hardware has an equivalent ground-unit so instrumentation can be routinely evaluated and transported to the ISS if necessary. The ground-unit ultrasound equipment must be evaluated every six months using a task performance sheet (TPS). A TPS is a document, written by the appropriate scientists and engineers, which describes how to run equipment and is written in such a way that astronauts with unspecialized training can follow the tasks. I was responsible for performing six TPSs on a combination of three ultrasounds and two video power converters (VPCs). Performing a TPS involves checking out and computationally documenting each piece of equipment removed from storage locations, setting up hardware and software, performing tasks to verify functionality, returning equipment, and logging items back into the computerized system. My work revealed all ground-unit ultrasounds were functioning properly. Because of proper function, a discrepancy report (DR) did not have to be opened. The TPS was then passed along to the Quality Engineering (QE) for review and ultimately given to Quality Assurance (QA).
Other projects: In addition to my main projects, I participated in other tasks including troubleshooting an EEG headband, volunteering for an ultrasound training research study, and conformal coating printed circuit boards.

My internship at SF4 has helped me understand how space systems hardware development for the ISS fits into NASA's mission and vision.