Using Simulation to Analyze Acoustic Environments

One of the main projects that was worked on this semester was creating an acoustic model for the Advanced Space Suit in Comsol Multiphysics. The geometry tools built into the software were used to create an accurate model of the helmet and upper torso of the suit. After running the simulation, plots of the sound pressure level within the suit were produced, as seen below in Figure 1. These plots show significant nulls which should be avoided when placing microphones inside the suit. In the future, this model can be easily adapted to changes in the suit design to determine optimal microphone placements and other acoustic properties.

Another major project was creating an acoustic diverter that will potentially be used to route audio into the Space Station's Node 1. The concept of the project was to create geometry to divert sound from a neighboring module, the US Lab, into Node 1. By doing this, no new audio equipment would need to be installed in Node 1. After creating an initial design for the diverter, analysis was performed in Comsol in order to determine how changes in geometry would affect acoustic performance, as shown in Figure 2. These results were used to produce a physical prototype diverter on a 3D printer. With the physical prototype, testing was conducted in an anechoic chamber to determine the true effectiveness of the design, as seen in Figure 3. The results from this testing have been compared to the Comsol simulation results to analyze how closely the Comsol results are to real-world performance. While the Comsol results do not seem to closely resemble the real world performance, this testing has provided valuable insight into how much trust can be placed in the results of Comsol simulations.

A final project that was worked on during this tour was the Audio Interface Unit (AIU) design for the Orion program. The AIU is a small device that will be used for as an audio communication device both during launch and on-orbit. The unit will have functions including push-to-talk buttons and volume control. With this project, an existing design was modified based on prior feedback that had been received. With the modified design, I created a 3D printed prototype, shown in Figure 4, which was then used in suited evaluations performed by crew members. The feedback received from those evaluations will be utilized to help create the best possible Orion AIU.

As a whole, a number of different interesting engineering projects were worked on over the course of this semester. For many of these projects, acoustic simulations provided valuable

insight into how different environments would respond to sound. While work is still underway to verify the results of these simulations, the results are fascinating because of the interesting ways that sound waves interact with the environment. Going forward, it will be interesting to see how closely these results can be matched by real-world test data.

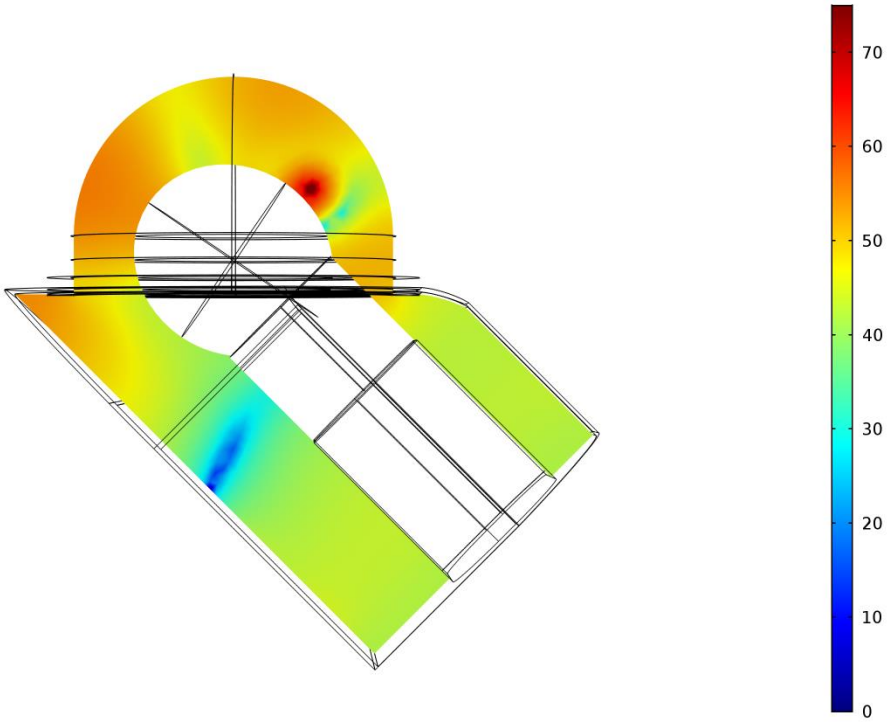

Figure 1: Acoustic Simulation of the Advanced Space Suit

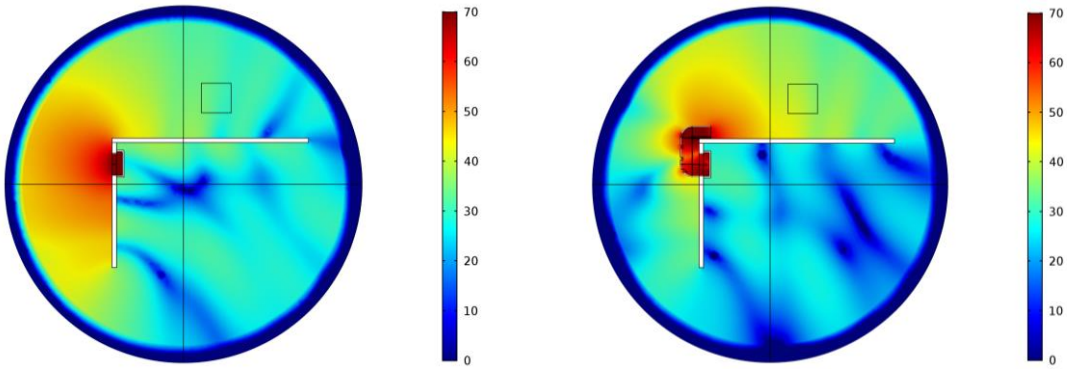

Figure 2: Acoustic Simulations with and without the Acoustic Diverter

Figure 3: Testing Setup to analyze the Acoustic Diverter

Figure 4: 3D Printed AIU Prototype