Joseph Carruth
MECH 328
Professor Hart
May 5, 2025

Design in Review

To begin the undertaking of creating my own aircraft, I had to create an initial mission profile using my imagination for what the aircraft would be able to do. In determining that I wanted a high-speed, long-range business jet with potential military & rescue capabilities, I started to envision the type of aircraft that would be required. Having drawn inspiration from the Coast Guards " HU-25 Guardian", a modified Dassault Falcon 20, and the Gulfstream 700, I began to tinker with designs that provided the most compatibility with my mission profile.

After completing initial sketches, I began to size the aircraft, using Raymer's *Aircraft Design* and supplemental examples to do the aerodynamic analysis of the wings and the weight requirements of the aircraft. Before I could actually design the aircraft, I had to make sure it met the requirements I had set out with. The hardest parts of this were ensuring the aircraft would meet the range and speed goals. Using Python, I adopted and created a sizing code to determine the initial weights and range of the aircraft based on the parameters from the aerodynamic analysis. After these began to converge, I found difficulty in meeting the range requirements set out for the aircraft with the max takeoff weight I had hoped for. Nonetheless, I knew I would need to make significant improvements in VSP to solve some of the issues.

Starting out in VSP, I began by creating the fuselage of the aircraft. Using similar height and widths of Gulfstream business jets, I began to experiment with different ways to make the cabin larger, make room for the internal wing structures, and have enhanced aerodynamic performance. I found the edit curve feature to be ultimately the most useful in constructing the fuselage, especially for the belly of the aircraft where the wings connected. In constructing the wings, I knew from aerodynamic research and analysis that I would need a supercritical airfoil to reduce the wave drag at high speeds, a common problem in transonic flight that dramatically reduces the efficiency of the aircraft. I kept iterating the wing to find the right span, chord and aspect ratio from the sizing. My creativity was expressed ultimately by the new tail design I established to make room for the rear-mounted engines and reduce the aircraft's overall drag. The design was a mix of V- and H-tails, providing a sleeker look to the aircraft, and transitioning from traditional T-tails, which I felt uncomfortable with due to their structure. This tail may require more wiring and more advanced pilots for turning the aircraft with ruddervators and rudders, while providing better maneuverability than the V-tail aircraft with solely their ruddervators.

After adding in the weights of the fuel, pilots, avionics, cabin, wiring, and more, I began to test the aerodynamic performance of the aircraft. Much of my effort was spent on positioning the neutral point of the aircraft aft of the center of gravity, which was achieved through effective weight distribution and wing positioning. After successfully balancing my aircraft, I found the parasitic drag of the entire aircraft, minus the engines, as the drag analysis was abnormally high with the engines, and in normal ranges for the rest of the aircraft. This analysis allowed me to find the range of the aircraft giving equations for total drag and lift and find that my aircraft met my range requirements using less than the max fuel capacity. Lastly, I did FEA structural analysis on the wings to better analyze the ribs and spars needed for my supercritical wings. After this, I added winglets, landing gear, and the engine core to have a more visually rounded out display for future 3D printing.