Optimization of the Wing Shape of a 65-Passenger Supersonic Business Jet

AE 4699 MAV Undergraduate Research

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Summary

For this project, I was tasked with optimizing the shape of the wing for a 65-pax supersonic business jet. The design already existed as an Engineering Sketch Pad (ESP) file and the team had already worked on optimizing the design, however the objective was to have me go through the process of running simulations over different parameters myself.

The given assignment was to choose 3 different parameters to change in order to optimize the design of the wing for maximum lift-to-drag ratio (L/D). After choosing the parameters, I was to create edit a pre-existing ESP .csm file in order to create all of the potential modifications to the wing I wanted to test, and then run the simulations on StarCCM+ using a pre-meshed template for a Mach 1.7 supersonic jet that the team had already been working with. With StarCCM+ calculating Cl and Cd for each modification I made, I could find an optimized shape.

I chose Aspect Ratio (AR), Taper Ratio (TR), and sweep angle as my parameters. I initially created 9 different modifications based off of my own intuitive method of isolating one variable at a time. For example, I perturbed AR while holding TR and sweep angle unchanged. In this way I could find out what effect AR by itself had on L/D. However, if occurred to me that many of these variables were connected to each other in ways that were more complex than I could currently understand, so I started to research better methods of optimization.
I researched the best optimization technique for changing three parameters in this situation and downloaded JMP on the advice of one of my professors. Using the Box Behnken method, JMP generated 15 combinations of parameter changes.

After creating my 15 modification cases, I created a macro that imported a new wing shape. Then I created 15 different folders from which to run each of the simulations in the Phoenix cluster.

The simulations have not yet been adequately run on the cluster due to the following difficulties:
I created files from the wrong shape on ESP, resulting in all of my 15 modifications being the same, and only just the fuselage.
There were meshing errors due to the use of the blended wing tip in my imported .stp files. Because of this, I needed to generate new .stp files using a “sharp” wingtip.
There were issues when transitioning from the StarCCM+ template I received, which included both a wing and a nacelle, and the version I was simulating, which was just the wing. Because of this, I needed to do some troubleshooting with the custom values, physics boundaries, and meshing in order to connect the correct attributes all together.
Finally, there are still 3d meshing errors that I am not experienced enough to troubleshoot.

As of now, I have no results for this project due to time constraints and all the issues stated above. In the future, I would like to gain more experience in troubleshooting meshing errors so that I can push forward with this project and find the optimal wing shape for my given design space.