Advanced Configurations Division – Supersonic Business Jet Wing Optimization

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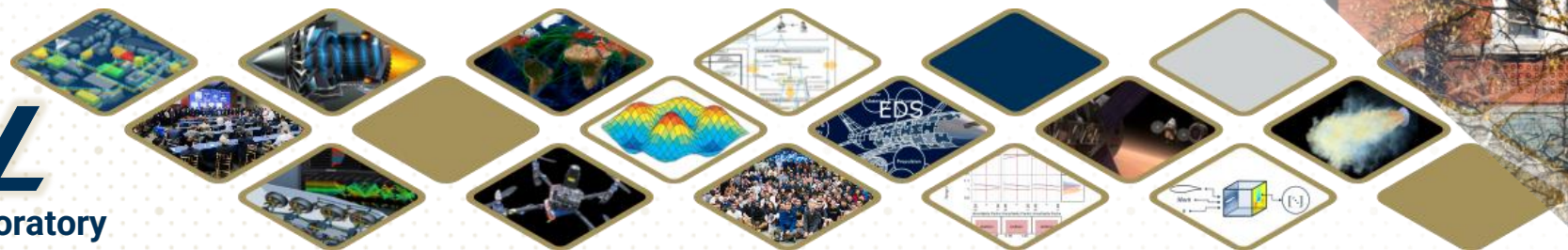
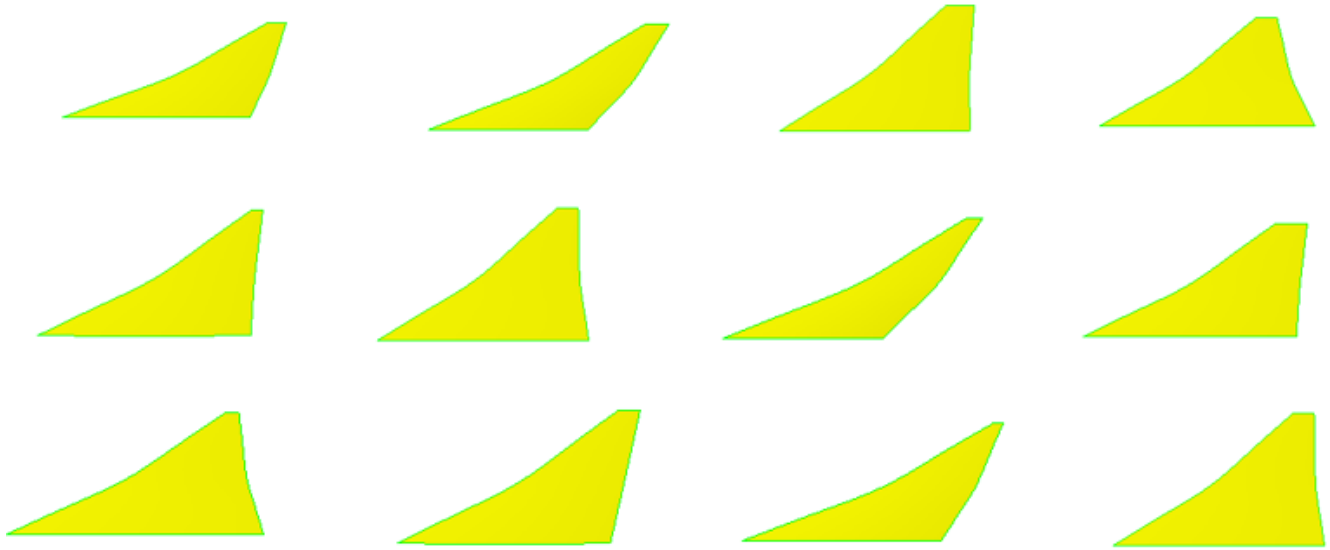


Aerospace Systems Design Laboratory

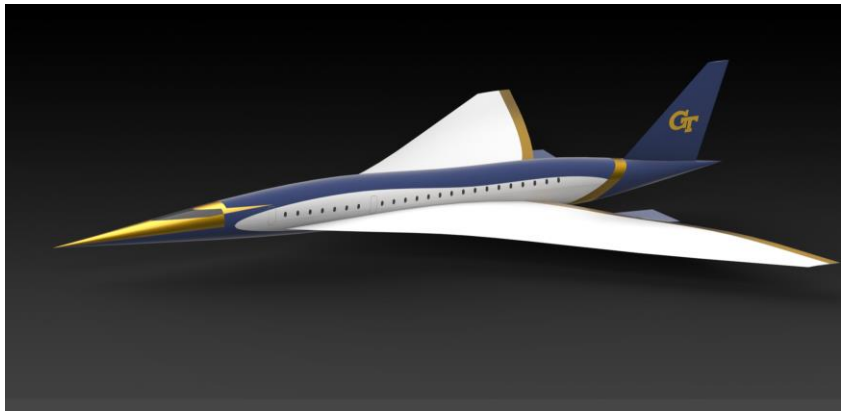
Objective

- Optimize wing shape for existing design of a 65-pax supersonic business jet
  - Choose three parameters to change
  - Run a minimum 9 simulations over 3 different angles of attack
  - Choose design that optimizes L/D



Why this project?

- Learn what parameters most effect the lift to drag ratio
- Gain experience in design optimization problem
- Study difference between my own solution and the Team's solution



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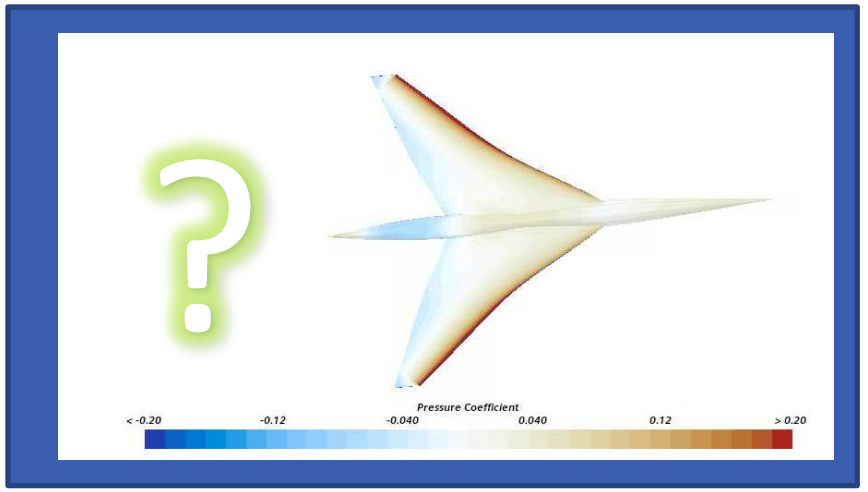

1. Image by Dr. Jai Ahuja

Technical Approach

- Choose parameters
  - AR +/- 0.5
  - TR +/- 0.05
  - Sweep +/- 7.5 deg
- Optimization
  - JMP
  - Box Behnken Method
- Build each wing in ESP
- Record Macro to switch wings
- Run simulations on the cluster and plug Cl/Cd into JMP for analysis

Box-Behnken - JMP Pro

File Edit Tables Rows Cols DOE Analyze Graph Tools View Window Help

Box-Behnken

Design Box-Behnken

Model

Evaluate Design

DOE Dialog

Columns (5/0)

Pattern

AR *

TR *

Sweep Angle *

Cl/Cd *

Rows

All rows 15

Selected 1

	Pattern	AR	TR	Sweep Angle	Cl/Cd
1	−0+	2	0.1	60	•
2	0++	2.5	0.15	60	•
3	0+−	2.5	0.15	45	•
4	−0−	2	0.1	45	•
5	0−−	2.5	0.05	45	•
6	000	2.5	0.1	52.5	•
7	+0−	3	0.1	45	•
8	+0+	3	0.1	60	•
9	−+0	2	0.15	52.5	•
10	+−0	3	0.05	52.5	•
11	++0	3	0.15	52.5	•
12	−−0	2	0.05	52.5	•
13	000	2.5	0.1	52.5	•
14	0−+	2.5	0.05	60	•
15	000	2.5	0.1	52.5	•

Difficulties, Mistakes

- STARCCM+ Macro editing
  - Recorded macro to swap out the wing for another file, forgot to change the filename afterward: ran 15 simulations of the same thing
- ESP .stp dumping of the wrong shape
  - Created .stps of 15 different mods…of the fuselage
- STARCCM+ naming and connections
  - Used template file of pre-created mesh that included a nacelle, needed a lot of help understanding the connections between the mesh operations, physics operations, naming conventions, etc
- Need to use sharp wing to prevent possible meshing errors
  - Had to generate .stp files all over again
- Mesh is still not properly generated, creating critical errors when running on the cluster
  - Need experienced help to figure out what looks wrong about it

Lessons Learned and Knowledge Gained

- Lessons learned:
  - **Write code you don't think you'll need for tedious file processing**
    - I thought I'd only have to make 15 .stp files and 15 folders for them once. Not the case.
  - Babysit your simulations on the cluster
  - Everything takes three times as long as you think it will
- Knowledge Gained
  - How to read the log files
  - How the team generates complex geometry on ESP
  - Recording Macros to replace geometry on STARCCM+
  - Mild troubleshooting with STARCCM+
  - JMP optimization methods for this type of problem

What's Next?

- Figure out meshing issues
- Run simulations and perform analysis
- Configure macro to run simulations over 3 different angles of attack
- Plug in results to JMP
- Study results, analyze, and synthesize conclusion
- Build optimized design in ESP
- Try to incorporate nacelle

…Thank you, Jai, Christian, Srujal!