Zoox Inc.:

Thermal System Intern

Task:

As an intern, I was tasked with leading a high-priority, understaffed flow-mapping test stand project for Zoox's L5 vehicle powertrain and battery cooling system, which had been stagnating for the past 2 years. This project was challenging because I had no prior experience in testing coolant flow systems or operating specialized equipment such as pressure sensors, flowmeters, thermocouples, valves, and pumps.

Method:

I began by drafting a Gantt chart detailing the approximate timeline of the project, which I then used as a foundation for twice-weekly updates to my manager. Since the project was outside my area of expertise, I had to be proactive and unafraid to ask questions. With the technician not always available, I took the initiative to build the entire test stand and install almost all the powertrain and battery components. Throughout the internship, I learned to interpret P&IDs, design instrumentation diagrams, and grasp the fundamentals of LIN Master/Slave control. Specifically, I became proficient in reading electrical harness diagrams and operating various pressure sensors, flowmeters, and thermocouples. I visited the office frequently on weekends to troubleshoot electrical connections and conduct additional tests to average out random errors.

Result:

The results were tangible, measurable, and quantifiable.

Within 9 weeks, I had completed the test stand and produced various sets of pressure drop and flow rate data for my team. My manager also highlighted that I had generated more data in those 9 weeks than the project had in the previous two years.

Furthermore, I went above and beyond by writing an automation script in VBS that reduced the testing time from an original 3 hours to just 30 minutes. I was the first on the team to automate the testing process through scripting, as all previous flow mapping tests had been manually controlled.

Volvo Trucks North America:

Powertrain Simulation Intern

Task:

My primary responsibility was the CFD optimization of a swirl air-coolant separation tank that separates air and coolant using a swirling mechanism. Within the tank's dynamics, the air, due to its lower momentum, gravitates to the center and rises, while the coolant, possessing greater momentum, flows alongside the tank's wall. I was given an initial conceptual design as a starting point.

Method:

This project is challenging in that I had absolutely ZERO support among my team as this is a pioneering simulation involving Eulerian-Eulerian multiphase flow. Since E-E simulation is especially sensitive to input parameters, I approached the project by reading various literature and publications and attempting to replicate their result. Once I have validated my simulation results against published papers, I then proceed to perform simulation and iterative designs on the initial swirl tank concept.

I again had to work independently with minimal supervision due to my team's unfamiliarity with the concept. The bulk of this project involved an abundant amount of trial and errors in input parameters and working overtime on weekends overseeing the simulation to make sure they have all converged correctly.

Result:

The result was measurable and quantifiable. I have identified the optimal air-coolant mixture entry velocity into the tank. In addition, I was able to optimize the geometry such that it maintained a separation efficiency of 99% while decreasing its mass from the original concept by almost 40%.

MASA (University Rocketry Team)

Rocket Fin Lead (Team of 12)

Task:

I was tasked with leading a team of 12 other student engineers to design the fins for an unprecedented 27-foot liquid engine rocket that goes to Mach 4.49. Due to the rocket's massive dimension, the fins have to be massive (3 ft-wide, 4 ft-tall) in order to ensure stability. This problem challenged my skills in leadership and management, in addition to my technical knowledge in fluid dynamics, heat transfer, and structural engineering.

Method

I divided the project into several segments and organized them in sequential order:

1. Obtain from the chief engineer the macroscopic vehicle target and requirements.
2. From the macroscopic requirements, derive the basic dimensions for the fin geometry.
3. Given the fin geometry, do the following in parallel.
    a. Use CFD software to obtain aerothermal forces and heating on the fin (ANSYS Fluent)
    b. Design a basic supporting structure within the fin geometry.
4. Given the CFD forces, use ANSYS Suite to analyze the structural deformation and thermostructural safety factor.
5. Iterate structural design until a satisfactory safety factor has been reached (SF > 1.5)
    a. During iteration, conduct manufacturability review with the production team.
    b. Conduct Preliminary Design Review(s) (PDR)
6. Conduct Critical Design Review
7. Make production drawings and co-ordinate with out-of-house manufacturers to finally produce the prototype.
8. Conduct structural and wind tunnel testing on the prototype to anchor the simulations and quantify aerodynamic forces.

I separated out the team into 2 different groups, structural design, and aerodynamic analysis. The teams would at first work together to determine the overall product requirement and sizing, and then separate out into conducting their structural design and CFD analysis respectively. I acted as the manager that oversaw the entire operation and helped my team with my technical knowledge when needed.

Result:

We were able to design *and* manufacture a fully aluminum fin assembly able to take on the aerothermodynamic load at Mach 4.49 with a 2-degree angle of attack.

We were able to co-ordinate with external manufacturers and produce our first prototype in just 3 months.

We also validated our manufactured prototype against structural FEA simulation, where we obtained an error margin under 20%. We have also placed our fins within the University's largest wind tunnel, where we obtained valuable aerodynamic data such as corrective aerodynamic moments with respect to airspeed.