Reflection Essay

ENGR 416

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6/9/2026

The HALE Structures and recovery team revolved around designing and building an active roll control system for the next generation of HALE's liquid engine rocket, CETUS, designed for going to approximately 35000ft. The rocket currently lacks any form of positional control once in flight, and our team laid the initial groundwork for developing and testing that system. Limiting the scope to roll mitigation and developing the path for advancing to full pitch and yaw control in the future. The rocket uses flaps embedded in the base of the fins to create counteracting moments in response to any disturbance. This should allow the next iteration of HALE rockets to reach greater heights.

Critical Thinking:

The project's initial complexity was incredibly daunting at first. It involved designing precise mechanical components, building advanced flight simulation in software no team member had ever used before, and developing a complete code package that both proved flight control and actively controlled the prototype. This came from an excessive amount of research and discussion. This project was so far beyond the initial capabilities of our team that hours had to be spent on YouTube and the internet. Watching numerous videos by people who would share only what they were willing to give to the internet. Particularly with a sensitive technology like this, which applies so easily to warfare. This heavily mitigated what resources and tools were available to open access, requiring careful sleuthing and discussion with many people to find the correct trajectory. This gives me a framework for how to develop projects and technologies in the future where information is limited and research provides scant results, allowing me to be innovative and creative in my own future endeavors.

Technology:

This project required me to learn many new technologies I had never used before. Including Siemens NX, ANSYS Fluent, Simulink, and advanced MATLAB programs. This combination of continuous new technologies and complicated setups required a massive amount of innovation with each passing week. One week, I may have been required to learn how to model CFD for the first time, the next, I had to learn an entirely new way of programming mechanical components with Simulink. This constant switching of technologies based on our needs really threw me in the deep end. Particularly with the application of Simulink, only near the end of our project did I realize we would need to use it, so I spent several days watching tutorials and practicing its various applications, until I eventually built a much more advanced system that worked very effectively and successfully managed to simulate the roll of our rocket during flight. This gave me a huge boost in technologies listed in my repertoire, which I can confidently say I have a great handle on now, demonstrating to me the necessary skill it needs to be able to quickly and efficiently learn any new technology required for a project to be a successful engineer.

Teamwork:

This project required a large amount of teamwork because no single person on our team had the complete skillset needed to finish the system alone. The project required mechanical design, CFD analysis, Simulink modeling, Arduino integration, wiring, manufacturing considerations, and communication with the larger HALE team, which required each person to take ownership of their own section while still making sure that every part connected back into the final system. For example, the fin flap design had to work mechanically inside the rocket fins, but it also had to match the assumptions being used in ANSYS and Simulink. This forced me to think beyond just my own work and consider how every design choice affected the rest of the project. This prepared me for a future engineering career because most aerospace projects require working across many different disciplines, trusting other people's expertise, and communicating clearly so that the final system works as one complete design.

Communication:

Communication became incredibly important throughout this project because the system itself was very difficult to explain. Active roll control involves aerodynamics, sensors, software, control logic, and mechanical motion, all working together at the same time. Early on, I understood pieces of the project, but explaining the entire system in a clear way was much harder. This became especially important when creating presentations, posters, documentation, and handoff materials for people who did not have the same background knowledge. A major part of this was learning how to explain the control loop in a simple sequence, where the rocket experiences a roll disturbance, the IMU reads the motion, the controller calculates a response, and the fins move to create a counteracting moment. This prepared me for my future career because engineering does not only require building or analyzing a system, but also explaining complicated ideas in a way that teammates, supervisors, and future teams can actually understand.

Professionalism:

Professionalism was developed throughout this project because the work had to be treated as more than just a class assignment. Since our capstone was connected to HALE and the future development of CETUS, the quality of our documentation, files, prototype, and final handoff mattered beyond simply getting a grade. We had to organize CAD files, ANSYS simulations, Simulink models, Arduino code, testing procedures, electrical diagrams, and the final report so that future members of the HALE team could understand and build from what we created. This required a much higher level of attention to detail because poor documentation would make the project almost useless after our team left. This prepared me for a professional engineering environment because real engineering work has to be understandable, repeatable, and reliable for the people who inherit it later.