

Team Final Approach
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Postmortem

Tyler Darnell

Colton Farrar

Zachary S. Kayser

Thomas O'Brien

Daniel Varner

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Project Sponsor: W. L. GORE

Faculty Advisor: David Alexander Trevas

Introduction

The Northern Arizona University SAE Aero Micro capstone team has completed one semester of the two-semester long senior design project. The team made significant progress on the plane last semester, completing the overall design, and developing prototypes of various components. The team was also able to gather almost all the parts and begin construction of the plane. This postmortem will serve as a way for the team to address major questions surrounding the progress made last semester.

Contributors to Project Success

Purpose and Goals

The overall goal that was described in the Team Charter was the design and construction of a remote-control aircraft that was as light as possible, while also being able to carry the most payload. Though the team has not fully completed the construction of the aircraft, they did complete a thorough design process, as well as adjusting the design for the newly released 2021 rules. From this, the team was forced to make some heavy design alterations to the craft in order for it to adhere to the new set of rules. The team also made major changes that allow the craft to score more points with the new competition rules.

Over the break, the team worked diligently with Tim Kelly of the Flagstaff Flyers to laser cut pieces of foam board used to construct the fuselage of the craft and team has nearly completed the construction of the wings of the craft. With the majority of the construction of the fuselage and wings of the craft completed, the team has recently ordered all of the electrical components that will be used to power and control the craft, as well as components that are required for the new competition rules (red arming plug). With many of these parts having recently arrived to the team by mail, the team will have a fully constructed and operational prototype in the near future. Therefore, it is the belief of the team that the goal of designing a remote-controlled aircraft was a success, and all team members plan to continue striving to complete the second half of the goal: the construction and successful flight of the aircraft designed.

Ground Rules and Coping Strategies

Team Final Approach has had adequate time to verify whether the ground rules and coping strategies within the team charter are working to facilitate the team's success. Within the ground rules, it is stated that the primary means of communication will occur over discord video calls and over the phone. These two means of communication have proven to be a perfect mode of communication for the team. The team agreed that scheduled meetings would be mandatory and while some members have missed a meeting here and there, overall attendance has been great. Recaps of previous meetings are used to keep everyone on the same page and any types of conflicts are resolved using the majority rule method. These ground rules and coping strategies have proven to be an effective method for the team.

It was also stated in the team charter that everyone is responsible for the successes and failures of the team and that everyone must participate equally. This has proven to be a successful way of placing accountability and some of these ground rules also act as coping strategies. For example, entirely remote communication helps students cope with the issues that have arisen with COVID-19 and has been a successful method for keeping all members of the group safe and comfortable. Another successful coping strategy that the Final Approach team put in place was seeking information from topic relevant specialists. This coping strategy has helped the team validate its progression. Much of the Final Approach Team Charter has proven to be successful, as well as useful, but may have been the result of having good team members rather than the provided team structure.

One thing that did not work well at the start of the project was time management for due dates. There were some accounts where team members did not finish their work by the designated due date, which led to some grievance in the team. Using the team's ground rules and coping strategies, the team was able to talk to this team member and discuss this issue with him in a respectful way using our coping strategies

and ground rules. The result has been perfect time management by the team for the remainder of the semester.

Positive Aspects of the Project

In the previous semester the team cooperated, communicated, and worked diligently on all the tasks and assignments that were assigned to them. This allowed for much of the tasks, reports, and presentations to be completed ahead of schedule and allowed for additional time for editing to make it as professional as possible. This was mainly accomplished by the team's effective communication by utilizing various mediums of communication. These methods included group texts, Discord meetings, and Zoom meetings at least once a week. By implementing constant communication between team members, the team was always able to know the task each team member was working on and the progress made on said task.

The team was also able to save money by utilizing the parts and components that were left over by the previous SAE Aero teams in the NAU Machine Shop. This eased the burden of competition feeds and even allowed for some testing before buying any new components. Finally, the team was able to increase the speed, efficiency, and cost-effectiveness of the manufacturing process by using the laser cutters at both the NAU Machine Shop and Tim Kelly's workshop (a member of the Flagstaff Flyers who have contributed to our technical knowledge and project as a whole). This allowed the team to cut several pieces of foam board and plywood for free and have enough spare pieces in case repairs or replacements are needed.

Tools, Methodologies and Practices

The team's utilization of various forms of communication have contributed very positively to the performance of the team. The team was able to use the virtual communication software listed above (such as Zoom and Discord) to communicate with each other and the Flagstaff Flyers. This also allowed for easy file sharing between group members to help or review others' work.

The team also took on the practice of having work completed well in advance of deadlines in order to provide the necessary time to review and finalize the teams work prior to submission. The team was able to take advantage of the ease of communication to constantly be checking in with each other in case group members were falling behind or struggling with their work. For larger assignments, the team not only split the tasks up evenly, but divided up sections for group members to review others' work. The team then chose one individual to go back over the entire assignment to conduct a final read through to ensure the assignment had the proper flow.

Finally, the team utilized SolidWorks extensively throughout the project. A final SolidWorks model is not only a requirement of the competition, but allows the team to visualize the prototype and quickly make laser cutting files. SolidWorks in combination with the technical skills and tools learned in Fluid Mechanics, Electrical Engineering, and other classes have helped the design semester to move efficiently and smoothly.

Technical Lessons Learned

Each team member learned different technical skills throughout the first semester of the project that have aided in the design and development of the airplane. Tyler focused primarily on wing design and learned technical skills involving CAD modeling and aerodynamic calculations. Colton learned how to design rib and spar wings to create a stronger and lighter structure, as well as modeling these wings within SolidWorks. Zachary's focus was on the design and force analysis relevant to the various design stages of the fuselage as well as the technical aspects of the integrated circuit necessary to operate the aircraft. Thomas worked with the team to help develop the fuselage, as well as design and select the avionics of the aircraft. Finally, Daniel learned how to develop a proper website for the capstone team, as well as determining the attributes to select the correct battery and motor for the craft.

The team also learned valuable skills in terms of aircraft construction from Tim Kelly of the Flagstaff

Flyers, which contributed to the team's overall technical knowledge. Tim has years of experience as an RC airplane fabricator, and the small bits of technical knowledge he provides have been extremely helpful as the team moved towards a final design. Through this work as individuals, and our combined knowledge as a team, a final design has been completed and is in the works of fabrication.

Opportunities for Improvement

Negative Aspects

While everyone hopes that a project will always move smoothly without any hiccups, engineers know this is never possible. The primary negative aspect during the design semester was that the restrictions implemented due to the COVID-19 pandemic have made it more difficult for the team to meet and work on the project in-person. Therefore, much of the work has been completed online, leaving the physical construction of the craft to be delayed. Additionally, the busy schedules of every team member also proved to be a challenge for the team, as many other engineering projects and exams for other classes limited the time each member could contribute to the project. Additionally, the goal of the team was to have a physical and functioning prototype of the craft by the beginning of the Spring 2021. This has yet to be accomplished, mostly due to some of the team members not being physically present in Flagstaff over Winter break. Overall, it was the inability of the entire team to work on the construction of the craft in a single physical location due to many internal and external factors.

Another negative aspect of the project had to do with the official rules not being released until mid-way through the semester. The team was working off the old 2020 rules as they designed the plane, and mid-way through the semester a huge rule change was implemented into the new 2021 rules. This left many of the team members disgruntled and hit the team with some major setbacks. Finally, the team also had a few personal conflicts in terms of some members not finishing work on time or differences in opinions, which were settled in the end as noted in the Ground Rules and Coping Strategies section. Overall, the positives of the project far outweigh the negatives and the team is happy with the progress that has been made.

Team Struggles and Problems

The team encountered several struggles and issues due to COVID-19. The team had to plan and work around social distancing protocols when meeting to work on assignments to ensure each other's safety. This has led to a slower production pace in building the actual prototype aircraft. Another challenge the team had to face because of COVID-19 is the delay in delivery of materials for construction. Shipping times that would normally have taken a week look to be near a month in some cases.

Additional challenges the team faced included ensuring all group members understood when work had to be completed. With everything being online and multiple team members taking high level courses, the amount of work and due dates could sometimes get confused. Keeping track of the due dates allowed for the team to have plenty of time to review all the work prior to deadlines. Finally, other challenges the team faced was scheduling conflicts between group members and the Flagstaff Flyers, which resulted in not all members attending each meeting. This led to alternative meetings being scheduled or group members collecting questions from those that couldn't make it to the meeting.

In terms of design struggles, the team has had a few. As noted, the real rule set was released about mid-way through the semester, which set the team back greatly in terms of progress. The new rules also limited our power for our motor and set us with new limits for wings and launch protocols. These rules created design problems that the team worked through efficiently. As the team transitions into the construction phase, all members anticipate the amount of problems and struggles to increase due to the difficulty of fabricating a design. The team anticipates that they will struggle more in this phase and is prepared for the difficulties to come.

Organization to Improve Performance

Specific organizational actions that can be taken to improve the team's performance include setting up a

recurring team meeting. The team currently has a weekly meeting with Dr. Trevas, but there is no official meeting scheduled outside of this. Although they are not always necessary, having a specific time slot to meet with all team members can help rather than setting up meetings on random days and times. By creating this designated time slot to meet and discuss small updates with the group, the overall communication can be significantly improved. The current method of sending text messages to the team group chat is effective, but meeting in a voice chat can allow each team member to express their thoughts and concerns in a much more efficient manner.

Additionally, improving the morale of the team can lead to much more success on the project. There is no current issue with any team member, but each member loses drive as the project slows down. As mentioned previously, the project slows down unexpectedly due to unforeseen circumstances such as delayed delivery dates and the lack of in-person interaction. Within these times the project slows or even comes to a halt, keeping the morale of the team high is vital to keep everyone interested and striving to build a competitive plane. By improving and maintaining a high morale, the team is certain to develop a more innovative and successful plane.

Finally, another possible method to improve organization would be to have a team schedule on google drive. This schedule would include everyone's schedules, as well as the due dates of each assignment throughout the semester. All these ideas could help improve the team's organization and the team will look to implement them this coming semester.

Conclusion

Overall, the team is very satisfied with the progress and accomplishments of the first semester. While COVID-19 had a huge impact on the ability to work as a team, all members were able to overcome these challenges and provide an important role in the design of the micro airplane. The team was able to complete the first half of the purpose and goals stated in the team charter and while there were some negative aspects of the project, namely the restrictions due to COVID-19, the positives of completing a design and the work that has been completed on the fabrication of that design far outweigh them. The team realizes that there is still much to accomplish in the coming semester, specifically the final construction of the plane and the optimization to follow, but as the team transitions into a new semester, it is the hope of all members that the effort and design work of the previous semester will lead to a successful assembly and an even more successful first test flight.