

HR 2 BREAKDOWN

TEAM: 20F12 - Final Approach

Due Date: **Friday, March 19, 2021 at 11:59pm**

Current Progress

Since the completion of the previous hardware review, the team has worked diligently to complete the build of the prototype of the aircraft and test its flying capabilities. With a series of successful flight attempts completed, the team is now focused on developing testing procedures that will be able to accurately measure the performance aspects of the drive system as well as the lift forces produced by the wings and the drag forces that the craft will experience. These testing systems will allow the team to have the ability to accurately measure the performance of the aircraft. Lastly, the testing systems and procedures developed by the team will greatly aid 2021 SAE Aero Micro team as they will have the opportunity to optimize the performance of their aircraft in the early stages of development by using the test stands and methods developed by the current team. The figures presented below demonstrate the progress the team has made and the current materials/prototypes available.

Figure 1 shows the final airplane design that the team built. The team has currently shifted focus towards test stand design, and thus this design is likely the final that the team will build. The airplane flew (as shown in Figure 2) so the team is happy with the design overall.



Figure 1 - Final Airplane Design

Figure 2 shows the airplane midflight. The plane flew three successful flights with no compromising damage.



Figure 2 - Airplane mid-flight

Figure 3 shows the thrust test stand the team purchased to test the thrust produced by the motor.



Figure 3 - Thrust test stand (purchased)

Figure 4 shows the lift/drag test stand design the team intends to construct. The team had already purchased many of the materials necessary for construction, and are currently waiting on the following materials to come in the mail:

1. Frictionless roller
2. Spring Scales
3. Car Mount

Non-specialty components such as the plywood base and tubing can be purchased at a local store and the team is currently in the progress of selecting final dimensions before purchasing anything else.

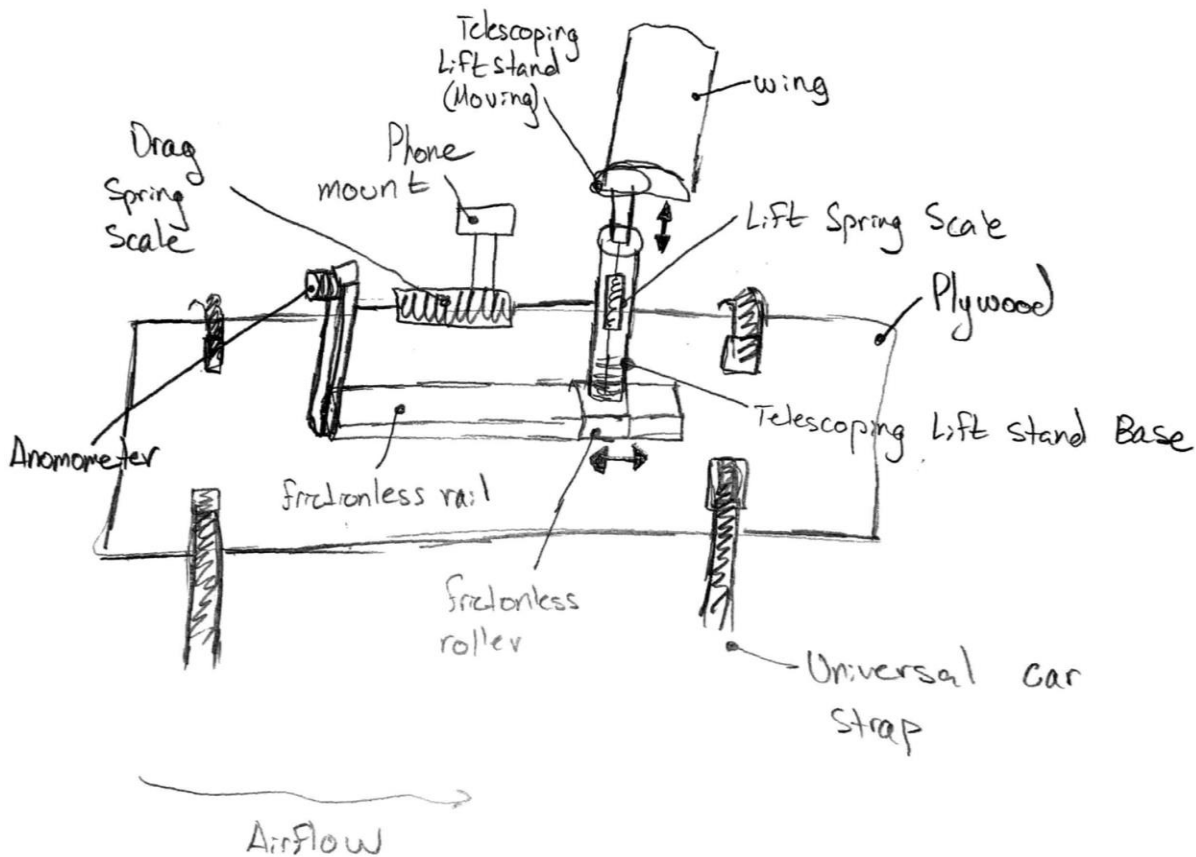


Figure 4 - Lift/drag test stand design

Action Items – Past

Each team member has completed a significant amount of work since the completion of the previous hardware review that have advanced the overall build of the craft and the testing implementations to acquire accurate performance aspects of the craft. Additionally, other tasks that were required for the progression of both the project and the class, such as purchase requests for materials, website development, and component research and selection were performed by various team members. The tables below feature the specific tasks performed by each individual team member, with the dates of completion for each task with proof and results provided of each completed task.

Table 1 - Team Member: Tyler Darnell

Action Item	Date Completed	Result/Proof of Completion
Updated CAD models and created E-drawing files.	1/13/2021	All SolidWorks components are completely up to date, and the E-drawings were used to laser cut most foam board pieces seen on the plane.
Researched test stand designs and found a thrust test stand to purchase.	2/15/2021	Team meetings with Dr. Trevas showed what was learned and the team recently picked up the thrust test stand that was selected.
Drew preliminary lift/drag test stand designs and validated feasibility of using spring scales.	3/12/2021	The preliminary test stand designs are shown in Figure 4, and the individual Analysis submitted on BBLearn shows the work that was done to validate the use of spring scales.

Table 2 - Team Member: Colton Farrar

Action Item	Date Completed	Result/Proof of Completion
Completed construction of the airplane and helped Zach secure the wings on the fuselage.	2/21/2021	Plane was completely finished and flown at the Flagstaff Flyers field (refer to figures of plane flying).
Verified the airplane's wings are structurally sound by completing an individual analysis on the torque and moment the spars experience.	3/8/2021	The spars do not experience a torque or bending moment that exceeds what they are capable of handling. The entire structure of the wings is satisfactory in terms of the materials and size of components. See individual analysis for calculations and proof of completion.
Found a 'frictionless' roller that will be used to secure the lift/drag test stand that allows for horizontal movement.	3/10/2021	McMaster-Carr sleeve bearing carriage was selected by the team. This roller will allow for horizontal motion while being near frictionless to allow the test stand to glide and put the spring scale in tension. Proof of completion in the purchase request and from Part No. 60585K38 via McMaster-Carr.

Table 3 - Team Member: Zachary S. Kayser

Action Item	Date Completed	Result/Proof of Completion
Finalize aircraft physical model, install aircraft rear landing gear.	2/21/21	The Aircraft was flown later that day and had a successful landing. Proof of such is found in timecards and the current state aircraft photographs included.
Review and investigate Strain gages/Wheatstone bridges for test stands contrasted with spring scales within the design of the team's test stands.	3/1/21	Furthering work completed before HR1, digital measuring devices were evaluated along with spring scales to determine a suitable approach and solution for the test stands being designed by the team. A recommendation was made to the team and the team's intent solidified during a staff meeting with Dr. Trevas.
Research and establish a mounting mechanism for the team's test stand design.	3/8/21	The team is working to design test stands that can be used by teams that follow. A universal mounting system that will ensure safety is required to fasten the test stand atop a car. A portable surfboard rack system provides the team with exactly such and has been incorporated into the current design and placed in the most recent purchase request forum.

Table 4 - Team Member: Thomas O'Brien

Action Item	Date Completed	Result/Proof of Completion
Researched potential use of strain gauges for testing stands	3/12/21	Conducted an analysis on potential strain gauges that could be used for the lift/drag test stand. This analysis was completed and submitted as an assignment. The team used this analysis to help decide between using strain gauges or spring scales for the test stand.
completed Purchase request for acquisition of test stand materials	3/15/21	The team had compiled a list of materials for purchase for the test stands. The team prepared a purchase request and reviewed the items with Dr. Trevas during the weekly meeting. After which the request was then finalized and sent to Dr. Trevas for approval.
Assisted Tyler with reviewing test stand design to help conceptualize certain aspects	3/13/21	Drawings were shown to Dr. Trevas during the team meeting on 3-15-21 for review prior to purchasing materials for construction.

Table 5 - Team Member: Daniel Varner

Action Item	Date Completed	Result/Proof of Completion
Updated team website to display the completed prototype of the craft and documents relating to the design and manufacturing process.	2/19/2021	Link to updated website is provided here: https://ceias.nau.edu/capstone/projects/ME/2021/20F12_SAEAeroMicro/
Research into thrust/drag stands and meeting with Prof. Willy to develop an initial implementation plan.	2/23/2021	Test stands were selected and purchased (see figures ### and ###) and wind tunnel airfoil testing procedure was abandoned for airfoil testing on top of a moving vehicle, collecting experimental lift and drag coefficients. These plans were documented in the Implementation Memo.
Research into thrust stands to examine their use and identify areas of the drive system and environmental conditions that will affect the performance.	3/12/2021	Thrust standing selected is featured in figure ### and the research performed for the thrust stand regarding its function and variables affecting the performance of the drive system and potential design alterations can be found in the Individual Analytical Analysis on BBLearn.

Action Items – Future

Table 6 presents the action items each team member intends to complete by the end of the project, as well as the expected due date. This table does not represent a comprehensive list of all action items but is rather meant to convey the major remaining tasks necessary to complete the project.

Table 6 - Future action items of each team member

Team Member	Action Items	Date Due
Tyler Darnell	<ol style="list-style-type: none"> 1. Aid in the construction and assembly of the lift/drag test stand. 2. Validate the lift/drag test stand and provide graphs/data of the results. 3. Assemble all SolidWorks parts into a final assembly. 	<ol style="list-style-type: none"> 1. 4/1/2021 2. 4/8/2021 3. 4/21/2021
Colton Farrar	<ol style="list-style-type: none"> 1. Secure roller track to plywood or some other surface. 2. Design phone mount configuration for recording wind speeds and spring scale readings. 3. Develop an operation/assembly manual for the plane with the team. 	<ol style="list-style-type: none"> 1. 4/4/2021 2. 4/10/2021 3. 4/16/2021
Zachary S. Kayser	<ol style="list-style-type: none"> 1. Design and construct lift/drag test stand base/mount 2. Collect physical model photos for poster 3. Complete Final BOM 	<ol style="list-style-type: none"> 1. 3/31/2021 2. 4/2/2021 3. 4/7/2021

Thomas O'Brien	<ol style="list-style-type: none"> 1. Assist in the construction of the lift/drag test stand 2. Begin formatting and layout for u-grads poster 3. Assist in final uploads of all necessary documentation to team website 	<ol style="list-style-type: none"> 1. 3/31/21 2. 4/2/21 3. 4/25/21
Daniel Varner	<ol style="list-style-type: none"> 1. Complete initial testing of the drive system using thrust stand. 2. Upload video(s) of flights and thrust/drag stands on team website 3. Complete alterations of the drive system to improve thrust, measure results on thrust stand. 	<ol style="list-style-type: none"> 1. 3/31/2021 2. 3/26/2021 3. 4/7/2021

Implementation Plan

The team is awaiting the arrival of materials to construct the lift/drag test stand, along with placing final orders for construction materials. Once the materials arrive, the team will begin the construction of the stand, as well as conduct preliminary tests to make any design changes necessary. The lift/drag test stand shown in Figure 4 will consist of two concentric pieces of PVC that will contain a mount to secure the airfoil to. This PVC will be placed on a frictionless roller that will allow the system to move horizontally, as well as move vertically to measure the lift. As the airfoil/system is moved horizontally and vertically, spring scales will be put in tension and the force at which it is being pulled will be recorded via a mobile phone. This entire setup will be placed on the roof of a car to reach high wind speeds that simulate actual flight of the plane.

As the materials begin to arrive within the next few weeks, the construction of the lift/drag test stand will be the primary focus of the team. The wing that the team has constructed will be used in the test stand to compare the theoretical calculations with the actual testing data. This will allow the team to compare the values and validate the theoretical lift and drag calculations that were made to ensure the most accurate values possible and ensure that all test stands are working properly for future capstone teams. Completion of the lift and drag test stand will be the final material construction of the project.

After the completion of the test stand construction and testing, the team will focus on preparing final reports and presentations, updating the website, and preparing the presentation poster for UGRADS. Because the plane is already completed and the team is ahead of the initial schedule, it is expected that the future action items will also be completed on time. Thus, the remaining time after the completion of the test stand will be devoted to completing the remaining class specific tasks necessary to graduate.

The Gantt chart shown in Appendix A contains a thorough timeline of the remaining plans that the team has. The notable action items from Table 6 have been added and the percentage of completion noted. The team is currently on track to complete the entire project, but the final months of capstone will require significant effort to complete all necessary items.

Note: Should the Gantt chart in Appendix A prove hard to read, the excel file that contains the entire Gantt chart has been attached to the document submission.

Appendix A – Gantt Chart

SAE Aero Micro

Team 20F12 Aero Micro
Tyler Darnell

SIMPLE GANTT CHART by Vertex42.com
<https://www.vertex42.com/ExcelTemplates/simple-gantt-chart.html>

Project Start:

Display Week:

