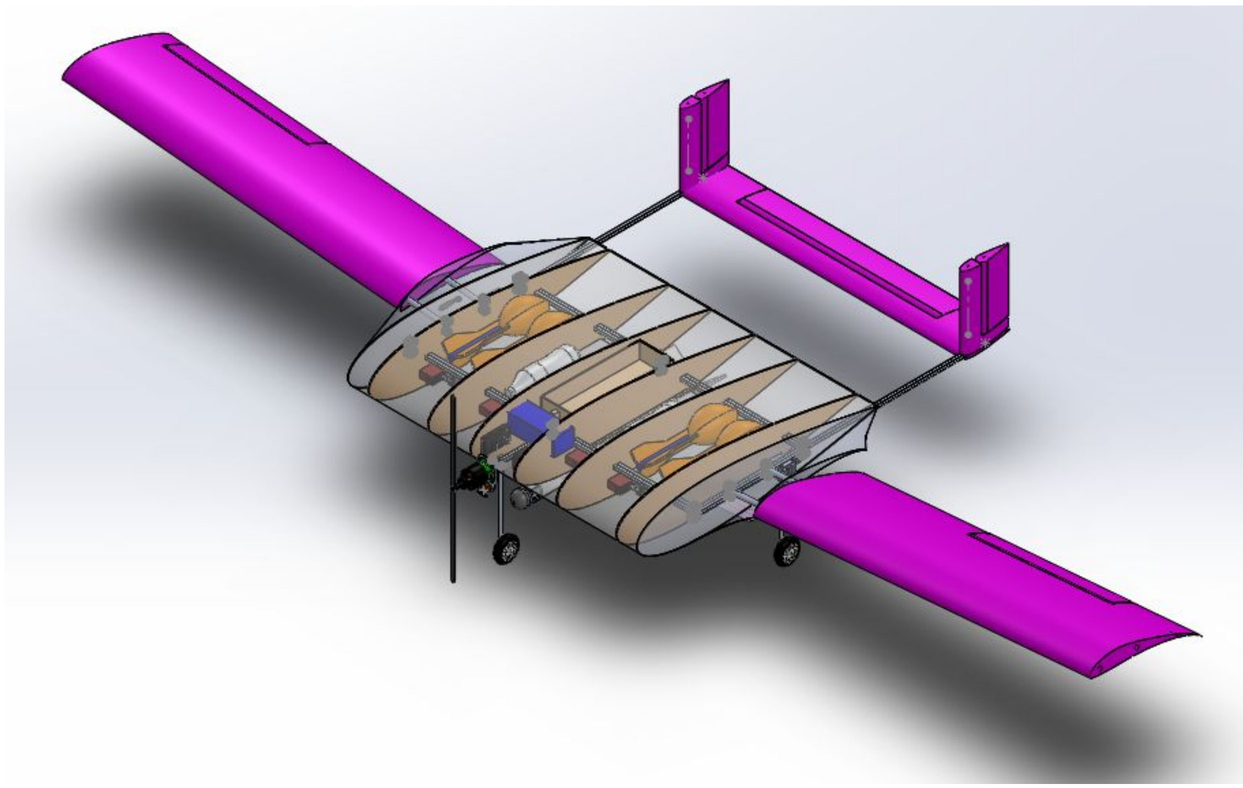
Kennesaw State University Aerial Robotics Team

Team 220



Name	Role
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Joel Morel	Assistant Lead
Raleigh Barden	Avionics
Lorenzo Stewart	Team Member

APPENDIX A

STATEMENT OF COMPLIANCE

Certification of Qualification

Team Name	KSU	Team Number	22Ø
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Faculty Advisor	Dr. Adeel Khalid		
Faculty Advisor's Email	akhalid2@kennesaw.edu		

Statement of Compliance

As faculty Adviser:

Ak (Initial) I certify that the registered team members are enrolled in collegiate courses.

Ak (Initial) I certify that this team has designed and constructed the radio controlled aircraft in the past nine (9) months with the intention to use this radio controlled aircraft in the **2019** SAE Aero Design competition, without direct assistance from professional engineers, R/C model experts, and/or related professionals.

Ak (Initial) I certify that this year's Design Report has original content written by members of this year's team.

Ak (Initial) I certify that all reused content have been properly referenced and is in compliance with the University's plagiarism and reuse policies.

Adeel Khalid 1/23/2019 — Signature of Faculty Advisor

Joshua Hunter 1/23/19 — Signature of Team Captain

Note: **A copy of this statement needs to be included in your Design Report as page 2 (Reference Section 4.3)**

Table Of Contents

1 Executive Summary **7**

2 Schedule Summary **8**

3 Environment and Requirement Review **9**

3.1 Environmental Considerations 9

3.2 Competitive Scoring and Strategy Analysis 9

4 Engine **11**

5 Design Layout & Trades **12**

5.1 Overall Design Layout 12

5.2 Trade Studies 14

6 Analysis **15**

6.1 Analytical Tools 15

6.2 Developed Models 15

6.3 Performance Analysis 15

6.3.1 Steady Level Flight 15

6.3.2 Bombing 16

6.3.3 CDA Flight Path 17

6.3.4 Lifting Performance, Payload Prediction, and Margin 17

6.3.5 Runway 19

6.3.5 Shading/Downwash 19

6.3.6 Dynamic & Static Stability 19

6.4 Structural Analysis 19

6.4.1 Design Loads 19

6.4.2 Frame 20

6.4.3 Control Surfaces 21

7 Avionics **21**

8 Manufacturing **22**

9 Cost **23**

10 Conclusion **24**

References **25**

Appendix **26**

Table of Figures

Figure 1 Gantt Chart……………………………………………………..………..............8

Figure 2 Scoring Graph……………………..…………………………...……………………10

Figure 3 Engine Test Stand……………………………..……………………………….......11

Figure 4 Engine Data………………………………...…………………………………......11

Figure 5 CDA V1.0……………………….…………...………………………………….….…...12

Figure 6 Bomber V1.0…….…….…...………………...…………………………….….….…12

Figure 7 Payload Layout..………………………………………………..………...……...13

Figure 8 Bomber V2.0…...……………………………...……………………………….……....13

Figure 9 CDA V5.0…………………………...…………….……………………...………14

Figure 10 Bomber V2.6………………………….………………….....……...………………..15

Figure 11 Bombing Path……………………………………………………….…………...16

Figure 12 Glide Polar CDA………………………………………………......…………....17

Figure 13 S1223 Airfoil CFD………………………………………………....…………....17

Figure 14 Lift and Cruise Speed…………………………..……………………………......18

Figure 15 Lift Over Drag……………………...………………………………….………..18

Figure 16 Frame materials……………………………………..…………………....………...20

Figure 17 V2.6 Frame………………….....……………...………….…………………………...20

Figure 18 Pixhawk……………………………………………..…………………....………...22

Figure 19 mini APM 3.1…………………………...………….……………………………...22

Figure 20 Frame……………………..…………………………..……………………………..22

Table of Tables

Table 1 Scoring Summary……………………….………………………...……………….12

Table 2 Environment Differences…………………………………………………………..14

Table 3 Bomber Cost………………………………………………………………….....23

Table 4 CDA Cost……………………………………..……………………………....23

Table of Acronyms

3D………………………………………………………………..………..Three Dimensional

CDA……………………………………...…………………......Colonist Delivery Aircraft

CFD……………………………………………………….....Computational Fluid Dynamics

CG…………………………………………………………….…………Center of Gravity

CNC……………………………………..…………...Computer Controlled Milling Machine

FEA…………………………………………………………………Finite Element Analysis

KSUARCT…………………..….Kennesaw State University Aerial Robotics Competition Team

PLA+...Poly Lactic Acid Plus

1 Executive Summary

This year serves as the first year that the Kennesaw State University Aerial Robotics Competition Team (KSUARCT) will be competing in the Society of Automotive Engineering (SAE) Aero Design East Division in the advance class category. The purpose of the advance class division is to construct a large size bomber-type aircraft and a small size Colonist Delivery Vehicle (CDA). The Bomber and CDA were designed and fabricated to achieve all of the goals set forth in the competition rulebook. The large bomber aircraft will carry releasable payloads, a FPV camera, and altitude logging capabilities.The CDA will be capable of a glide ratio between three and four and safely reach its destination without tripping the shock sensors onboard.

The design approach for this year is to ensure the bomber will successfully takeoff, fly, release the CDA, release the other releasable payloads, and land. It is projected that the CDA will be able to glide to the target zone assuming it was released from the bomber at the appropriate time window.

KSUARCT finds that the competition plane is within the SAE Aero Design rules, and within the team and university's guidelines. The team would like to thank Kennesaw State University (KSU), SAE, and our faculty advisor, Dr. Adeel Khalid for their support, and enabling us to compete in the SAE Aero Design East 2019 Event in Fort Worth, Texas.

2 Schedule Summary

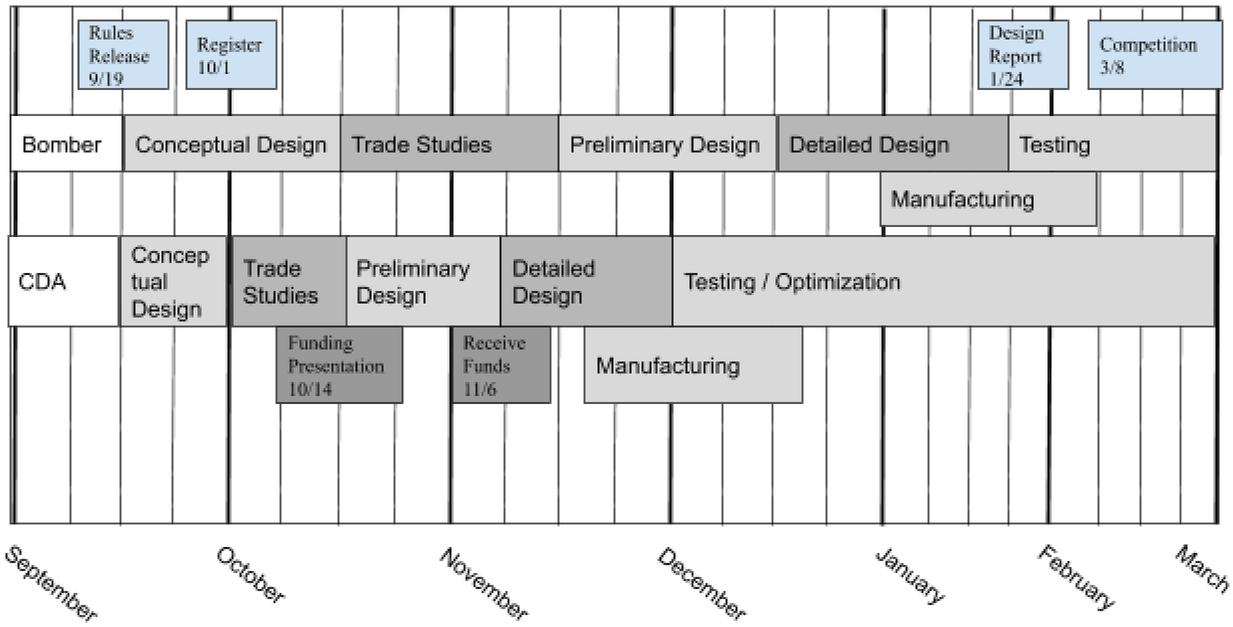


Figure 1. Gantt Chart Timeline

The timeline of the project began one month before the rules released. Due to the changes made to the rules, most of that progress was lost since it dealt with nitro motors. With the addition of designing the CDA and the dependencies of the CDA design on bomber performance, the design of the bomber had to be delayed. After initial design of the CDA was completed, bomber continued. Due to a funding delay with Kennesaw State University, the preliminary design was delayed by one month. This was due to the unknowns in designing the structural frame of the bomber. An increase in bureaucratic steps to order and receive parts that led to an additional two week delay in testing. These delays in the five month timeline led to a significantly decreased testing time window and an increase in expected design time compared to ideal conditions.

3 Environment and Requirement Review

3.1 Environmental Considerations

The differences between Standard day and Fort Worth, Texas environment based off historical data are as follows:

	Air Density (Slugs/ft^3)	Temperatur e (F)	Pressure (lbf/ft^2)
Standard Day	0.002377	59	2116
Average Percent Difference	0.587%	6.55%	1.64%

Table 1 Environment Differences

Another environmental consideration that is taken into account is wind. Following a review of historical weather data for Fort Worth, Texas, wind during the competition could range from zero to twenty miles per hour. As a way of compensating for this, the Bomber cruise speed was set to be at fifty feet per second to be able to handle a twenty mile per hour head wind.

3.2 Competitive Scoring and Strategy Analysis

The first objective of the conceptual design is to understand how the rules and scoring relate to the design of the aircraft. After reviewing the score equation, the score of one water bottle is equivalent to two Nerf footballs. Because of this, assuming that all payloads land in the supply zone, a payload set is defined as one water bottle and two nerf footballs. An excel document was made to graphically represent how the different payloads affect scoring, weight, and size required for payload bays.

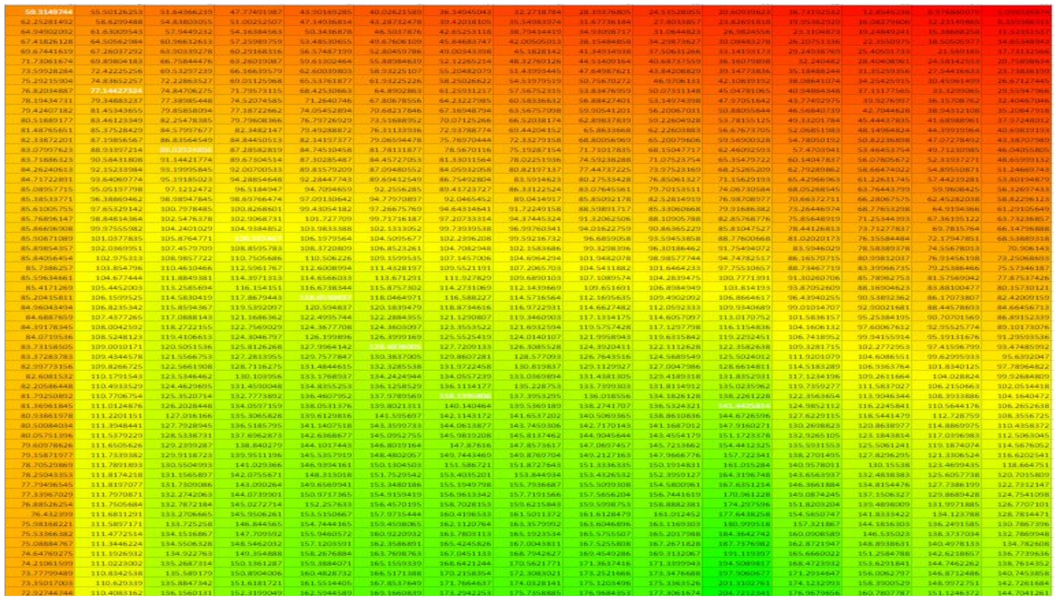


Figure 2 Scoring Graph

Following review of this graph, it was determined that the amount of colonists the CDA(s) can carry is the biggest limiting factor. This data has been summarized in the table below.

Colonists	Payload Sets	Weight of Dropping Payloads	Score with 16 lb total (remaining is static)	Score with 30 lb total (remaining is static)
9	2	4 lb	49	77
15	3	6 lb	61	89
24	4	8 lb	79	107
30	5	10 lb	90	118
35	6	12 lb	100	128
40	7	14 lb	110	138
41	11	22 lb	OverWeight	141

Table 2 Scoring Summary

This table allows us to more accurately make design decisions about payload versus weight without the general more payload equals a higher score after designing a iteration of the CDA.

4 Engine

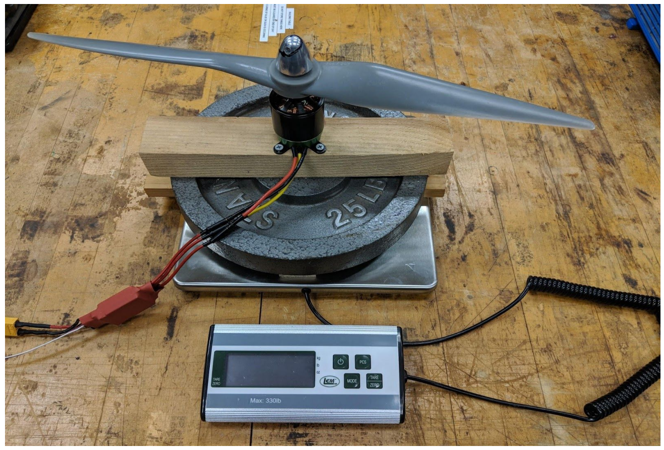


Figure 3 Engine Test Stand

The Engine was tested to determine the maximum thrust produced with a 750 watt limit using a scale, multimeter, and tachometer.

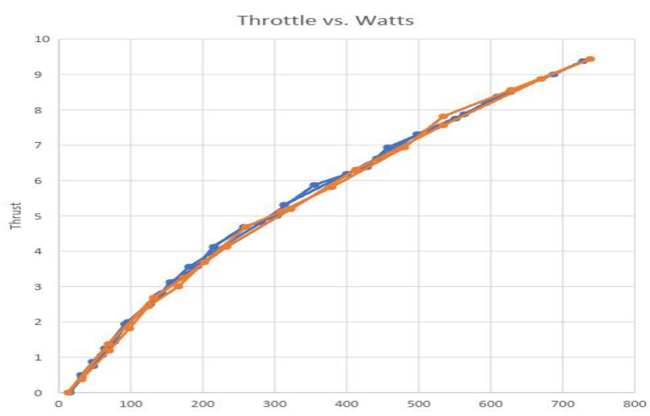


Figure 4 Engine Data

After testing different engines and prop sizes, the Cobra 4130/20 with an APC 20x8 inch propellor was selected due to it being capable of producing approximately seven pounds of thrust after removing an assumed loss. Dynamic testing of the motor and propellor setup was not possible due to limited equipment available to the team as well as budget and time restrictions.

5 Design Layout & Trades

5.1 Overall Design Layout

According to the data gathered from table 1 as previously discussed, we decided to make iterations for our CDA first.

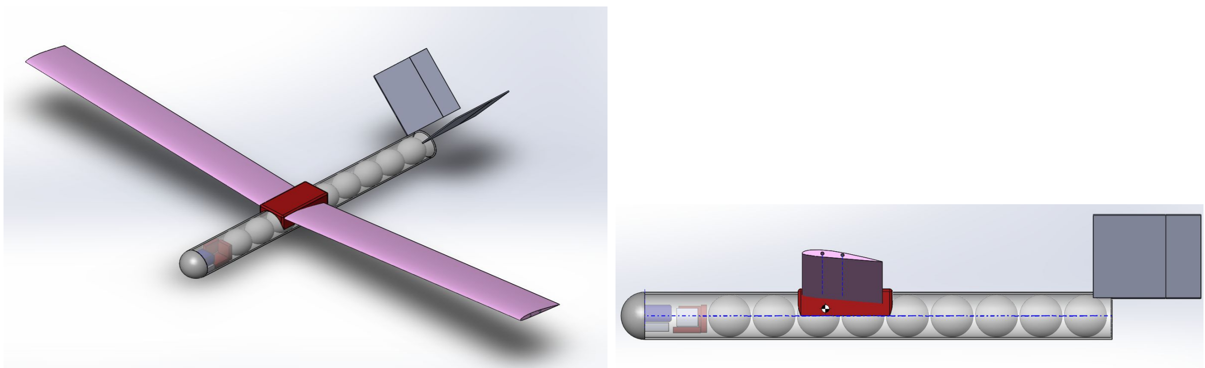


Figure 5 CDA V1.0

Airfoil: AG35 || Chord: 3in || Span: 3ft

In this iteration, the AG35 was selected as a basic airfoil that suited the needs of our mission. A standard tube was selected as a fuselage to house the colonists. A V-tail was decided on to be the main control surface of the aircraft in order to reduce weight from electronics in the aircraft. It was determined that nine ping pong balls could be carried by one CDA.

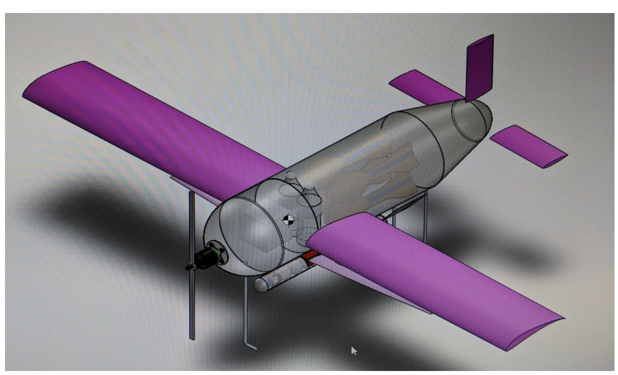


Figure 6 Bomber V1.0

The large size of the two payload sets require a large diameter fuselage compared to the rest of the plane. Three possible configurations of payloads were made to determined the size required for the fuselage as seen in Figure 7.

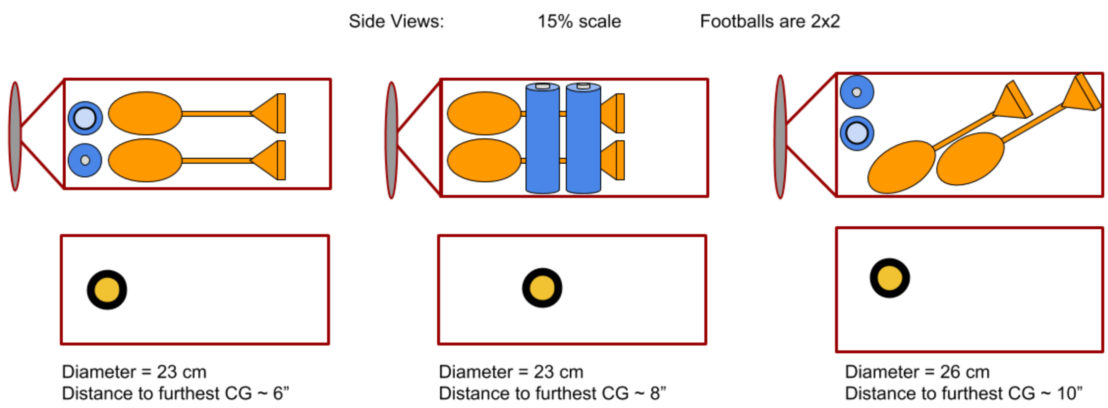


Figure 7 Payload Layout

This style of configuration would likely better work if the payloads could be further away from the CG longitudinally as seen by the Figure below. An additional fuselage configuration was looked at.

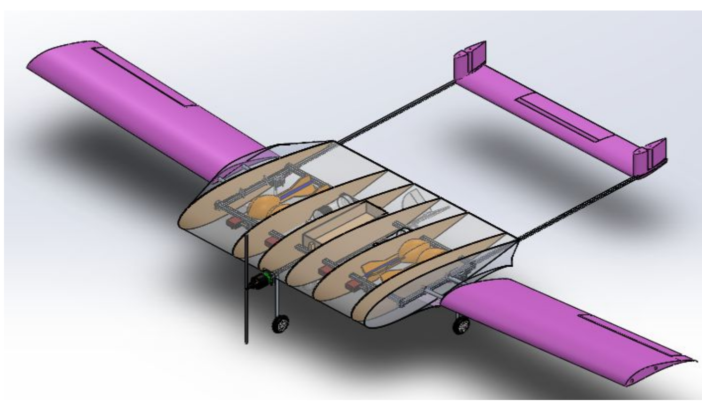


Figure 8 Bomber V2.0

Airfoil: S1223 || Chord: 14in || Span: 10ft

The blended wing configuration allows a fuselage that generates less drag than V1.0 and allows for the easier release of payloads. The downside to this style of configuration is that the wings are further away from the CG, generating more torque on the structural frame. The additional torque requires the frame to be stronger and heavier than the V1.0 frame. Due to the decrease in drag and faster release of payloads, the blended wing configuration was selected.

5.2 Trade Studies

After multiple iterations of the CDA, the following iteration was produced.

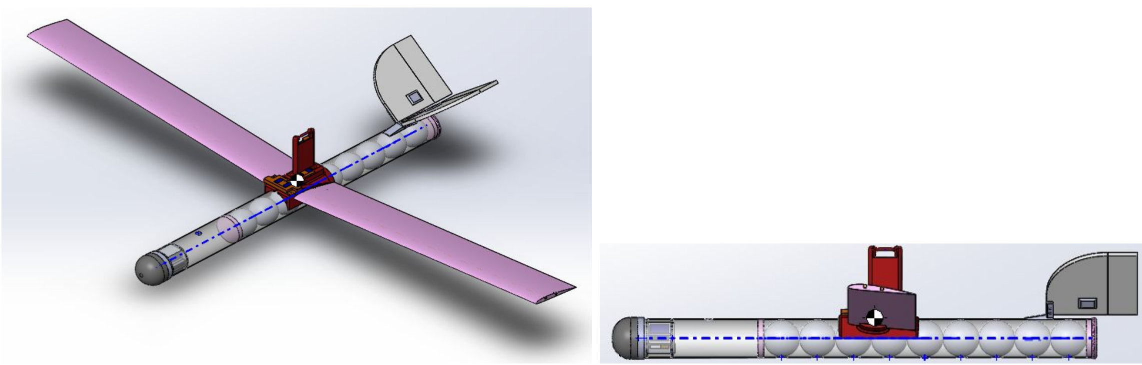


Figure 9 CDA V5.0

Airfoil: AG35 || Chord: 3in || Span: 3ft

This version of the CDA installs the finer details into the aircraft including holes to touch the colonists, a storage location for the electronics, a more detailed wing backpack to angle the wings properly while holding the g-force sensors, and a stronger bracket for the V-tail.

6 Analysis

6.1 Analytical Tools

The tools used to assist in design were SolidWorks, SolidWorks Simulation (FEA), and Solidworks Flow Simulation (CFD). Solidworks was used to make the design. Solidworks Simulation was used to perform structural calculations on the frame of the bomber. Solidworks Flow Simulation was used to perform numerous CFD calculations on the bomber and CDA.

6.2 Developed Models

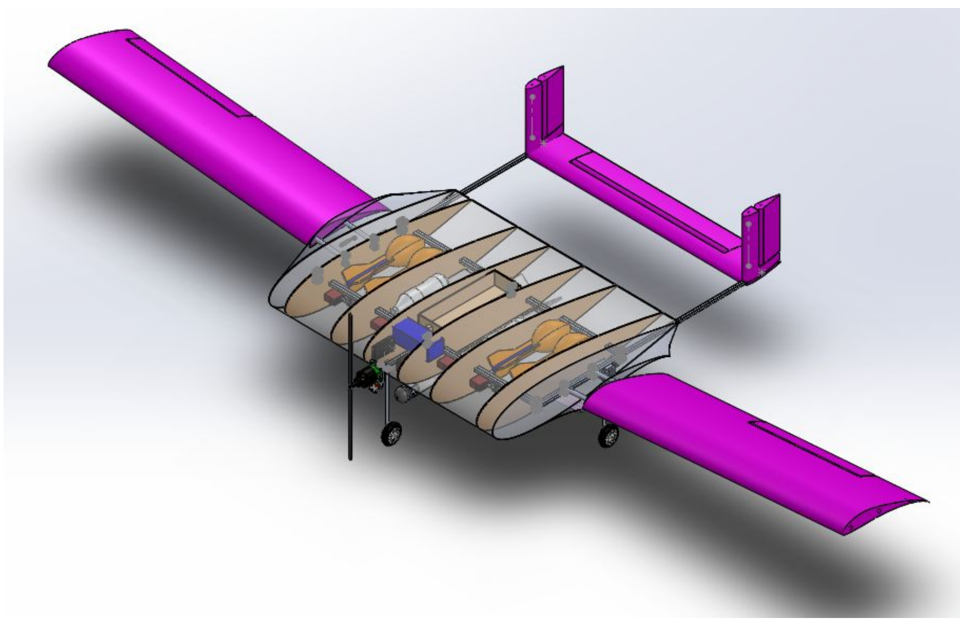


Figure 10 Bomber V2.6

6.3 Performance Analysis

6.3.1 Steady Level Flight

The bomber was designed to cruise at fifty feet per second at altitudes under two hundred feet with a drag that is half of the reasonable output of the thrust. This drag number of three pounds will allow cruising at fifty percent throttle.

The CDA has had successful test flights with a glide ratio of almost four achieved from a hand thrown velocity. A velocity that is a fraction of the intended initial velocity. This data shows that during competition conditions the CDA will have a glide ratio of around four, which is the designed ratio.

6.3.2 Bombing

The mechanics and theory we used for bombing was perfected by the end of World War Two. The basic figure below shows the required variables, courtesy of the United State Air Force. Altitude will be provided by the avionics and the time off fall is approximately two and a half seconds or one hundred feet based off of both theory and previous competition footage. The difference between the actual range and whole range is negligible due to the short distance that the aerodynamic payloads are falling, the assumed under thirty mile per hour winds, as well as the large size of the target. The whole range is theoretically calculated and based off of the bomber cruising speed the plane will have a two second window over the target. Assuming the bomber is lined up properly during the run, the team is confident in its ability to hit the target successfully.

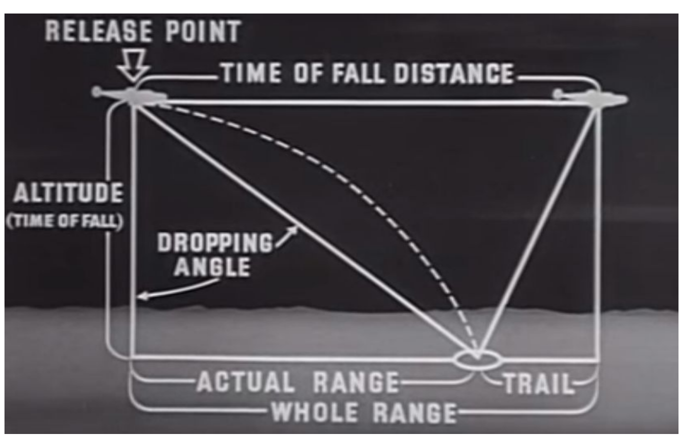


Figure 11 Bombing Path

6.3.3 CDA Flight Path

THe CDA was designed to have a glide ratio between four and three and between fifty feet per second and ten feet per second. CFD tests have been run to determine the glide polar as shown below. Physical flight tests were conducted to verify the correct glide ratio at low speeds.

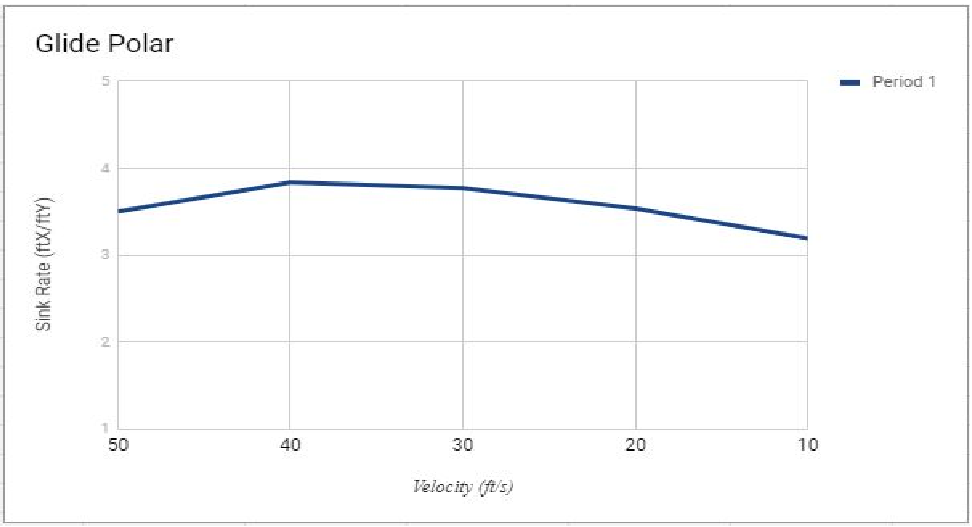


Figure 12 Glide Polar CDA

6.3.4 Lifting Performance, Payload Prediction, and Margin

The main wing uses a S1223 airfoil. This was chosen based off of the high Cl/Cd values in Reynolds numbers around 300,000 that was able to lift fifty five pounds while maintaining a low enough drag to fly in the current configuration.

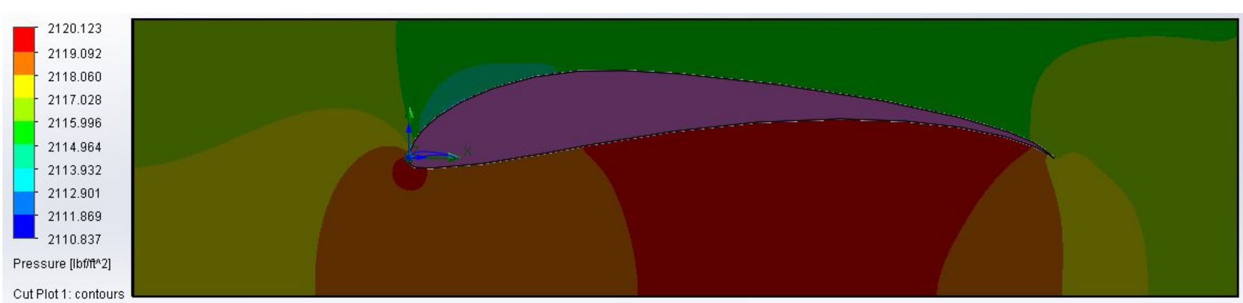


Figure 13 S1223 Airfoil CFD

Multiple CFD's were run at different wingspans and velocities to determine flight performance at a constant chord in terms of lift over drag, lift, and change in cruise speed with a set weight.

	7ft	(lbf)		8ft	(lbf)		9ft	(lbf)		10ft	(lbf)		11ft	(lbf)	
Velocity (ft/s)	L	D	L/D	L	D	L/D	L	D	L/D	L	D	L/D	L	D	L/D
20	6.8	-0.2	-34	8.05	-0.26	-30.9615	9.31	-0.35	-26.6	10.6	-0.43	-24.6512	11.99	-0.53	-22.6226
22	8.4	-0.24	-35	9.85	-0.33	-29.8485	11.36	-0.43	-26.4186	12.8	-0.52	-24.6154	14.5	-0.64	-22.6563
24	10	-0.28	-35.7143	11.77	-0.4	-29.425	13.59	-0.51	-26.6471	15.4	-0.63	-24.4444	17.3	-0.77	-22.4675
26	11.7	-0.32	-36.5625	13.74	-0.45	-30.5333	15.95	-0.61	-26.1475	18.1	-0.73	-24.7945	20.3	-0.89	-22.809
28	13.7	-0.38	-36.0526	16.16	-0.54	-29.9259	18.65	-0.71	-26.2676	21	-0.85	-24.7059	23.7	-1.06	-22.3585
30	15.9	-0.46	-34.5652	18.66	-0.63	-29.619	21.47	-0.8	-26.8375	24.07	-0.96	-25.0729	27.2	-1.21	-22.4793
32	18.1	-0.52	-34.8077	21.29	-0.72	-29.5694	24.7	-0.93	-26.5591	27.7	-1.11	-24.955	31	-1.38	-22.4638
34	20.7	-0.6	-34.5	24.15	-0.82	-29.4512	27.8	-1.05	-26.4762	31.5	-1.28	-24.6094	34.8	-1.56	-22.3077
36	23.2	-0.66	-35.1515	27.19	-0.93	-29.2366	31.1	-1.16	-26.8103	35.7	-1.47	-24.2857	39	-1.74	-22.4138
38	25.8	-0.73	-35.3425	30.55	-1.05	-29.0952	34.8	-1.32	-26.3636	39.1	-1.57	-24.9045	43.6	-1.94	-22.4742
40	28.8	-0.83	-34.6988	33.77	-1.15	-29.3652	38.71	-1.47	-26.3333	43.97	-1.76	-24.983	48.1	-2.16	-22.2685
42	31.7	-0.91	-34.8352	36.84	-1.16	-31.7586	42.6	-1.59	-26.7925	49	-2.04	-24.0196	53.1	-2.37	-22.4051
44	35	-1.02	-34.3137	40.81	-1.37	-29.7883	46.8	-1.76	-26.5909	52.5	-2.09	-25.1196	58.6	-2.63	-22.2814
46	38.6	-1.13	-34.1593	44.77	-1.53	-29.2614	51.06	-1.91	-26.733	57.7	-2.29	-25.1965	63.8	-2.87	-22.23
48	42	-1.22	-34.4262	48.75	-1.65	-29.5455	56	-2.12	-26.4151	62.6	-2.53	-24.7431	69.9	-3.16	-22.1203
50	44.7	-1.24	-36.0484	52.66	-1.77	-29.7514	60.5	-2.29	-26.4192	67.8	-2.75	-24.6545	75.6	-3.45	-21.913
52	49.2	-1.45	-33.931	57.2	-1.96	-29.1837	64.9	-2.41	-26.9295	73.9	-2.97	-24.8822	81.5	-3.72	-21.9086
54	53.2	-1.57	-33.8854	61.6	-2.08	-29.6154	69	-2.41	-28.6307	79.4	-3.2	-24.8125	87.5	-3.94	-22.2081
56	57	-1.66	-34.3373	66.1	-2.24	-29.5089	76.4	-2.91	-26.2543	85.6	-3.45	-24.8116	94.9	-4.32	-21.9676
58	60.9	-1.72	-35.407	71.1	-2.44	-29.1393	79.7	-2.87	-27.77	93.1	-3.91	-23.8107	101.2	-4.55	-22.2418
60	65.8	-1.93	-34.0933	76.05	-2.59	-29.3629	86.4	-3.21	-26.9159	98.1	-3.99	-24.5865	108.4	-4.87	-22.2587

Figure 14 Lift and Cruise Speed

Wingspan at// Temp 63F// Pressure 2151.74// Humidity 60%

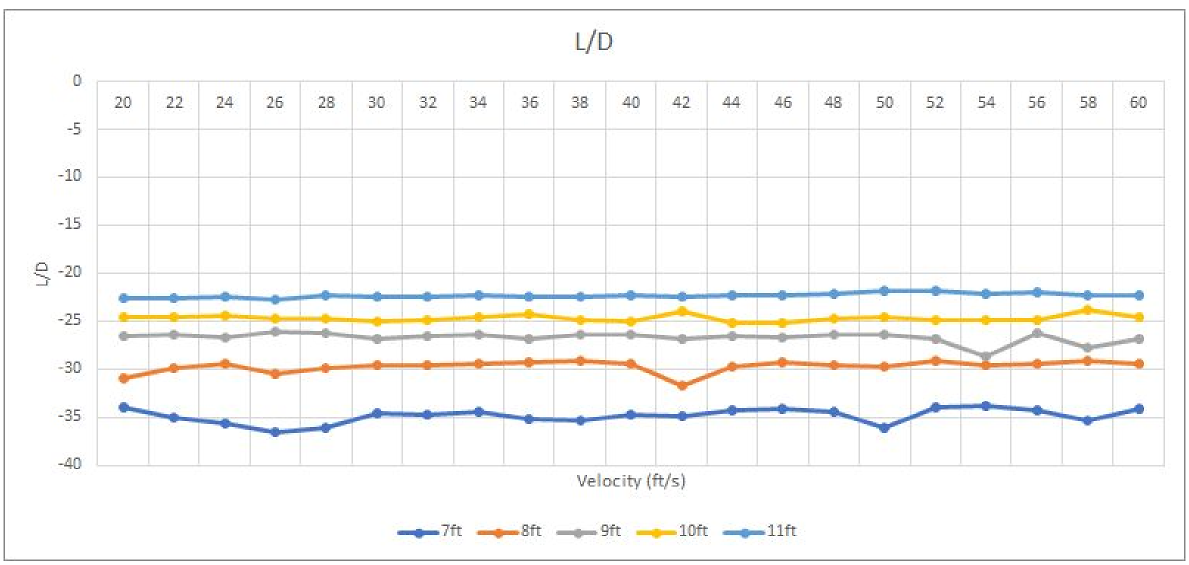


Figure 15 Lift Over Drag

After reviewing the two figures above, in addition to the historical thrust to weight ratio of a bomber and the environment considerations, the chord of the airfoil had to be decreased. This decrease in chord allowed a cruising speed of fifty feet per second with a lifting force equivalent to the weight based off of a historical thrust to weight ratio.

6.3.5 Runway

A CFD was run at multiple points along the zero to fifty feet per second graph to determine the function of the plane drag and lift as a function of speed. This data was put into equations with the thrust from the engine to determine the following assuming no wind and standard day.

Distance To Takeoff	~200 feet
Seconds to takeoff	~7 seconds

Table 3 Runway Performance

6.3.5 Shading/Downwash

Based upon historical data our Downwash angle is to be found aft of our wing at an angle of attack of eight degrees with the downwash angle of our tail at four degrees.

6.3.6 Dynamic & Static Stability

A dihedral has been added with the CG below the dihedral to act as a stable aircraft.

6.4 Structural Analysis

6.4.1 Design Loads

Based off the projected weight of the aircraft and consideration given to historical thrust to weight ratio for a bomber, theoretical calculations were done to determine loads as a function of safety factor. This allowed the team to build a load table and pick different materials to look at weight, size, ease of manufacturing, etc.

Name	In Diameter (in) [If tube]	Diameter (in)	Density (lb/in^3)	Volume (in^3)	Yield Strength (psi)	6' Cost	3' Cost	1' Cost	Total Cost	Total Weight (lbs)
High-Strength Grade 5 Titanium Rod w/o Certification		0.375	0.16	37.11	120,000.00	$88.10	$49.34	$19.38	$421.12	5.938
Hard High-Strength 7075 Aluminum Rod		0.375	0.1	37.11	62,000.00	$22.21	$12.66	$5.33	$106.83	3.711
High-Strength 2024 Aluminum Round Tube	0.43	0.5	0.1	17.179	42,000.00	$41.06	$23.81	$9.85	$197.90	1.718
6061 Aluminum Round Tubes	0.402	0.5	0.1	23.327	35,000.00	$33.31	$19.65	$8.33	$161.22	2.333
6061 Aluminum Rectangular Tubes	0.25	0.375	0.1	26.25	35,000.00	10.58	XXX	N/A	$52.90	2.625
High-Strength 1144 Carbon Steel Rod		0.3125	0.28	25.771	100,000.00	$6.16	$3.39	$1.48	$29.51	7.216
High-Strength Steel Threaded Rods 1/4"-20		0.25	0.036	16.493	150,000.00	$14.91	$8.72	$6.88	$75.24	0.594

Figure 16 Frame materials

Aluminum 6061 and 2024 were found to be the best candidates for the fabrication of critical areas of the aircraft frame.

6.4.2 Frame

A SolidWorks FEA analysis was run on the frame with different materials, and the frame shown in Figure 17 below shows the chosen aluminum frame. The results showed the frame have a safety factor under landing conditions of at least four. The aircraft was arranged so that the CG is at the quarter chord of the main wing. The FEA analysis proved to be inaccurate when compared to the actual testing done on the aluminum frame with proper incisions. The incisions were points at which holes were bored in to the frame, which dramatically decreased the strength. Physical testing was conducted and the frame had to be double mated with additional aluminum.

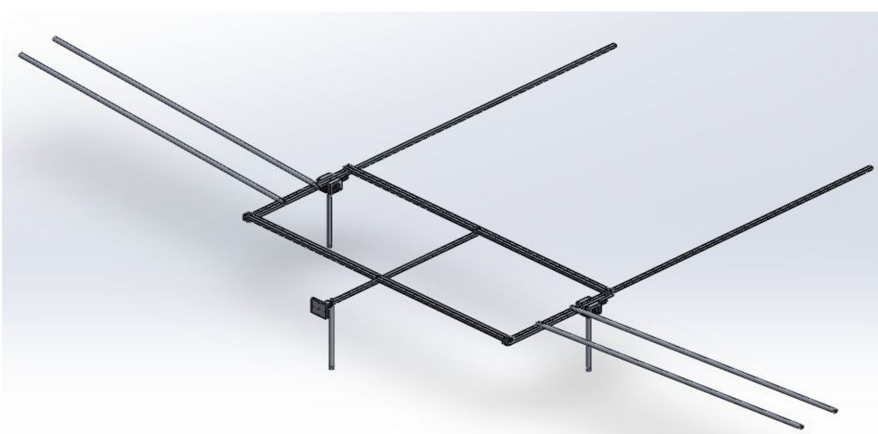


Figure 17 V2.6 Frame

For the CDA, the loaded aircraft weighs less than nine ounces. Due to this weight as well as the materials that were used such as carbon fiber, a structural analysis of the CDA was deemed not necessary. The aircraft was arranged so that the CG of the aircraft is at the quarter chord of the main wing.

6.4.3 Control Surfaces

After conducting controlled tests within Solidworks FEA, the elevator which is the biggest control surface has a reaction force of two and a half pounds at ninety degrees of rotation at cruise speed. The servos used for the control surfaces can handle at least an additional twenty percent of that value.

7 Avionics

Pixhawk || Servos || Landing Gear || Payload Bays || Camera || Pitot Tube

The Bomber aircraft is controlled using two Pixhawk flight controllers. The first of these is used to control the landing gear and the control surfaces of the aircraft. It is connected directly to the pilots controller. The second Pixhawk is used to control the payload bay servos, fpv camera and is the main data logger for the plane's altitude,velocity, and point of CDA/payload drop points. This Pixhawk is connected directly to the ground station. The use of two flight controllers in this manner makes sure that the pilot has no control over bombing and the bomber has no control over flying. Testing done on the accuracy of the altitude sensor on the Pixhawk determined that the embedded sensor was accurate within a foot, which are the requirements in the rules.

APM 3.1 || 2 Servos (V-tail)

The CDA uses a mini APM 3.1 flight controller to control the two servos in the V-tail. The set program adjust for slight disturbance in order to maintain a set course. This system allows control of the aircraft while minimizing weight from electronics, with the slight disadvantage of the glider's accuracy being left up to the pilot and bomber.

-mRo Pixhawk Flight Controller (Pixhawk 1)

-mini APM 3.1

Figure 18 Pixhawk

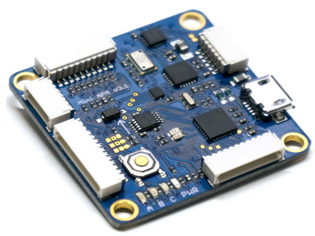


Figure 19 mini APM 3.1

8 Manufacturing

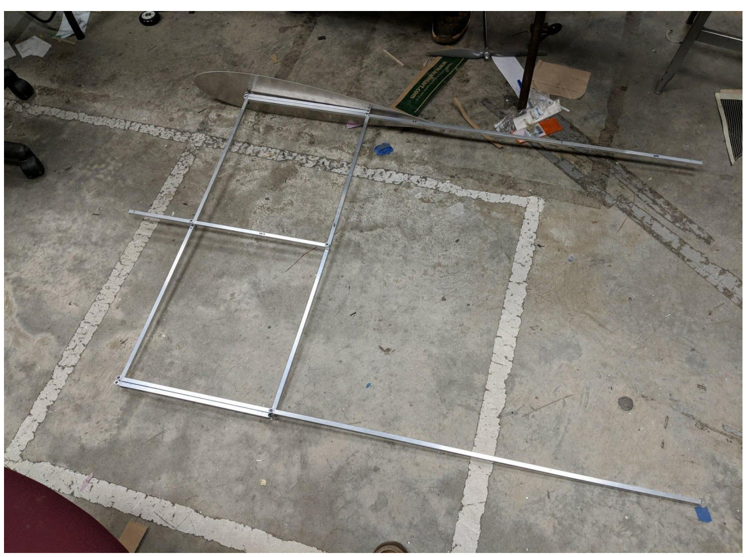


Figure 20 Frame

For the bomber, the main wing and empennage airfoils were hot wire cut. The fuselage airfoil is covered in monokote. The aluminum frame is machined out on a milling machine / vertical drill press. The motor mount and rear landing gear mounts were milled using a CNC machine. The front landing gear rod had to be partly machined using a lathe.

For the CDA, our fuselage was created by using a PVC pipe as a mold for a carbon fiber tube which we then slid off the pipe and trimmed down to size. The wing backpack, tail bracket, and electronics holder were 3d printed from PLA+ printing material. Wings were cut out of foam using a hotwire and then duct taped. There are wood spars in the wings that slid into the wing backpack.

9 Cost

The estimated cost of parts of the Bomber aircraft is:

Frame	$300
Airfoils	$20
Avionics	$400
Total	$720

Table 3 Bomber Cost

The estimated cost of parts of the CDA aircraft is:

Frame	$15
Airfoils	$1
Avionics	$110
Total	$126

Table 4 CDA Cost

10 Conclusion

Overall, the CDA was designed first and underwent five design iterations until a final design was determined and then performed multiple test flights. The bomber has been through two major iterations and six minor iterations. The bomber has been strenuously, theoretically tested and the frame was tested in physical trials to confirm its usability. Particularly, the team made sure to put an emphasis on the control surfaces to withstand turbulent weather conditions, and that the elevator could withstand twenty percent of maximum wind load during flight. Additionally, the frame is double mated to resist load fatigue and other possible forms of deformation.The two aircraft, after being put through thoroughly conducted tests and iterations, have been equipped with avionics consisting of two Pixhawks, APM 3.1 Flight Controller, servos,and an fpv camera. The current design now stands at a total cost of $846 USD. Moving forward into competition, the team believes that the design and calculations will provide for sufficient support in satisfying our mission requirements as the team participates in this year's SAE Aero Design East 2019 event..

References

[1] "2019 Collegiate Design Series SAE Aero Design Rules." Society of Automotive Engineering. Version 2019.4

[2] "Airfoil Tools." *Airfoil Data Information*, www.airfoiltools.com/.

[3] Raymer, Daniel P. *Aircraft Design: a Conceptual Approach*. 6th ed., American Institute of Aeronautics and Astronautics, Inc., 2018.

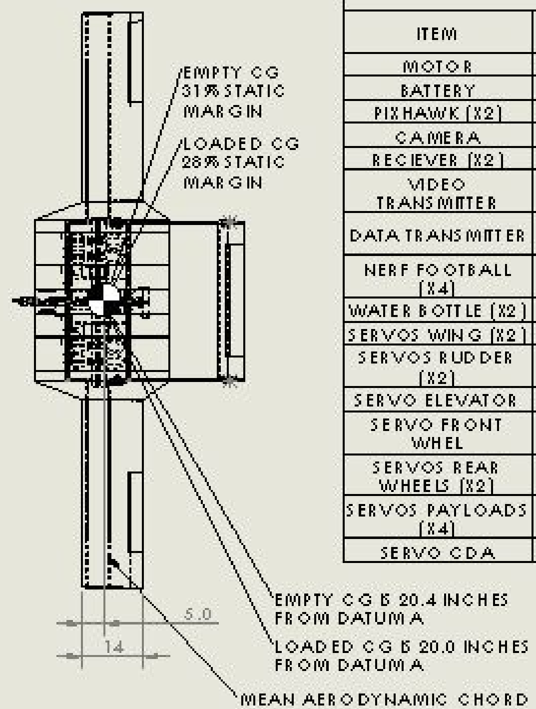
[4] Museum, Stockton Field Aviation. "Sperry S-1 Bombsight - Principles." *YouTube*, Google, 15 Apr. 2016, www.youtube.com/watch?v=CRlsF1U5vUw.

Appendix

Bending Stress (max) =	$\frac{M * .5 * D}{I}$
Moment of Inertia (Rod) =	$\frac{\pi * (.5 * D)^4}{4}$
Moment of Inertia (Tube) =	$\frac{\pi*((.5*D)^4-(.5*d)^4)}{4}$

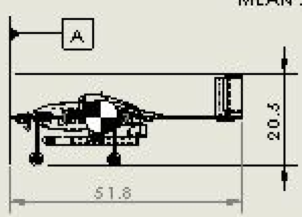
TEST:	
Bending Stress (Rod) =	$\frac{32 * M}{\pi * D^3}$
Diameter:	0.125
Stress =	1126480.862
Bending Stress (Tube) =	$\frac{32 * M * D}{\pi * (D^4 - d^4)}$
Outer Diameter:	0.5
Inner Diameter:	0.402
Stress =	30235.11754
Moment of Inertia (Sq. Tube) =	$\frac{(S-s)^4}{12}$
Bending Stress (SQ. Tube) =	$\frac{6 * M * D}{(D^4-d^4)}$
Outer Side:	0.375
Inner Side:	0.25
Stress =	30625.47692

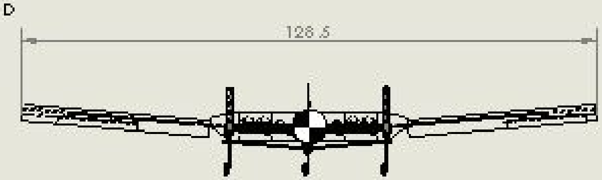
Formulas		Plane Angle 0 deg							
L =(Cl*p*(v^2)*Awing)/2		Thrust Engine (lbs)	Drag from Plane (lbs)	Drag total (lbs)	Cd	Aexposed (ft^2)	Lift (lb)	Al (ft^2)	v (ft/s)
D =(Cd*p*(v^2)*Aexp)/2		0.1	0.166615144	-0.06661514403	0.03015	5.166	49.6718041	22.54959	30
v = SQRT[(2L)/(pAlCl)] = SQRT[(2D)/(pAdCd)]		0.2	0.166615144	0.03338485597	0.03015	5.166	49.6718041	22.54959	30
		0.3	0.166615144	0.133384856	0.03015	5.166	49.6718041	22.54959	30



MOMENT ABOUT DATUM A			
ITEM	WEIGHT FORCE (OZ)	DISTANCE FROM DATUM A	RESULTED MOMENT (OZ-IN)
MOTOR	13.92	4.2	58.46
BATTERY	30.27	10.5	317.8
PIXHAWK (X2)	2.68	7.7	20.6
CAMERA	.63	3.9	2.46
RECIEVER (X2)	1.7	7.7	13.09
VIDEO TRANSMITTER	.18	7.7	1.39
DATA TRANSMITTER	0.85	7.7	6.55
NERF FOOTBALL (X4)	20	18.5	370
WATER BOTTLE (X2)	36.8	18	662
SERVOS WING (X2)	4.6	22	101
SERVOS RUDDER (X2)	4.6	46.6	214
SERVO ELEVATOR	2.3	46.6	107
SERVO FRONT WHEL	2.3	7.6	17.5
SERVOS REAR WHEELS (X2)	5.08	23.4	118.9
SERVOS PAYLOADS (X4)	9.2	11.8	108.6
SERVO CDA	2.3	19.4	44.6

PERTINENT DATA	
ITEM	DETAIL
WINGSPAN	128.5128.5 IN
EMPTY WEIGHT	18 POUNDS
BATERY CAPACITY	5000 MILLIAMPS
MOTOR	COBRA 4310-20
PROPELLOR	APC 20X 8
FLIGHT COMPUTER	PIXHAWK
CAMERA	RUN CAM FPV EAGLE 2
SERVO TORQUE	17.4 POUND INCH
SERVO POSITION	FRONT WHEEL, (X2) TAIL, (X3) EMMPANAGE, (X2) REAR WHEELS, (X4) PAYLOADS, CDA





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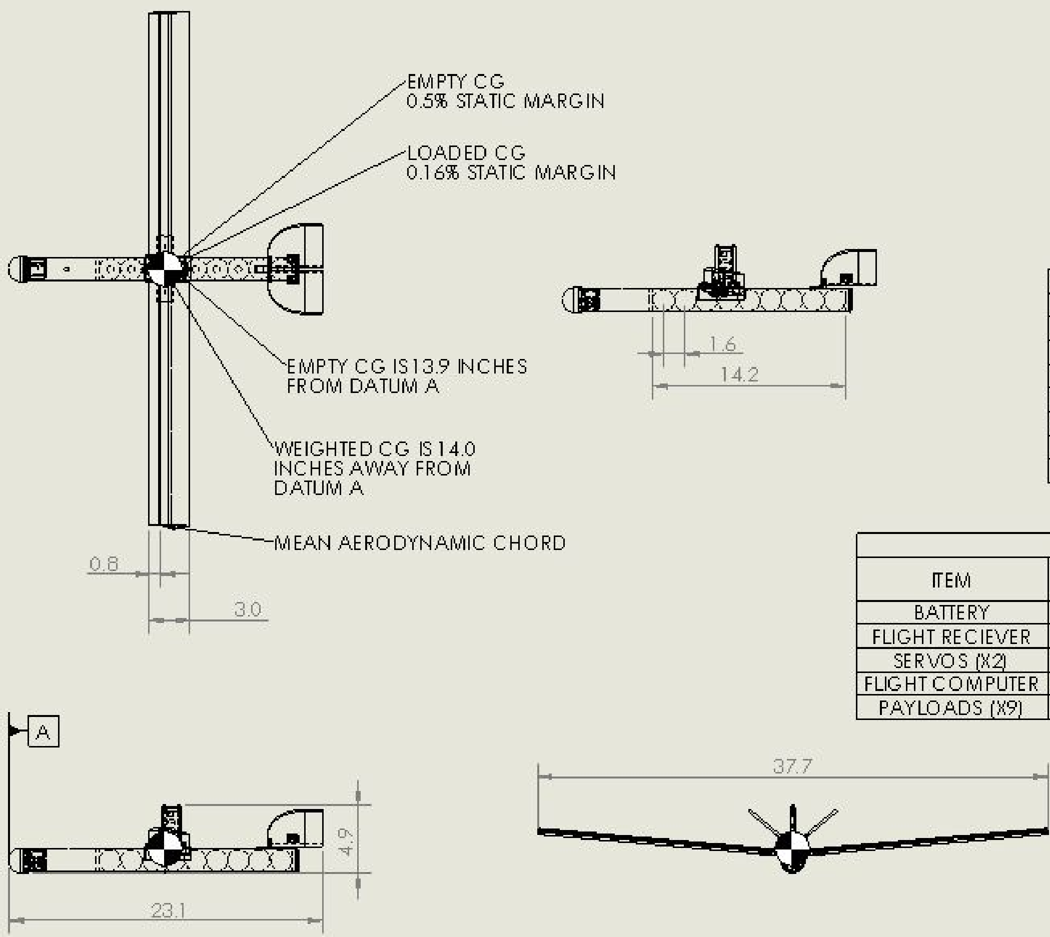
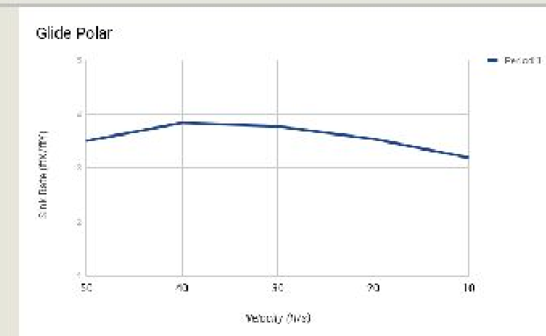
DATE: 1/24/2019	SCALE: 1:24	OF 1





PERTINENT DATA	
ITEM	DETAIL
WINGSPAN	37.7 INCHES
AIRFOIL	AG-35
EMPTY WEIGHT	8 OUNCES
BATTERY CAPACITY	400 MILLIAMP HOURS
FLIGHT COMPUTER	MINI APM 3.1
SERVO TORQUE	8.37 OUNCE * INCH
SERVO LOCAIONS	X2 AT TAIL

MOMENT ABOUT DATUM A			
ITEM	WEIGHT FORCE (OZ)	DISTANCE FROM DATUM A (IN)	RESULTED MOMENT (OZ-IN)
BATTERY	.67	1	.67
FLIGHT RECIEVER	.11	1	.11
SERVOS (X2)	.16	22	3.52
FLIGHT COMPUTER	.21	1	.21
PAYLOADS (X9)	.86	14	12.04

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