SAE - VIT AERODOMINATOR 7.0

TECHNICAL DESIGN REPORT

TEAM NAME: THE THIRD DIMENSION 1

TEAM NUMBER: AD-001

COLLEGE NAME: NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPALLI

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SAE-VIT
SAE INDIA |STUDENT CHAPTER

AERODOMINATOR 7.0

STATEMENT OF COMPLIANCE

Team Name: The Third Dimension 1

College Name: National Institute of Technology, Tiruchirappalli

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Statement of Compliance-

"As a Faculty Advisor, I certify that the registered team members are enrolled in collegiate courses. This team has designed, and/or modified the radio controlled airplane that they will use for SAE-VIT AERODOMINATOR 7.0 Competition, without direct assistance from professional engineers, R/C model experts or pilots, or related professionals."

Sep. 28, 2020
(Dr. R.B. Anand)

(Signature of Faculty Advisor)

(Signature of Team Captain)

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1. ABSTRACT

To design a hand launched micro class RC aircraft with a within a wing span of 85cm (including the width of the fuselage) that can provide enough lift to carry and deliver medical supplies(syringes, pills and tablets) and first aid in times of pandemic and be able to return after delivery.

2. REQUIREMENTS OF THE PROJECT

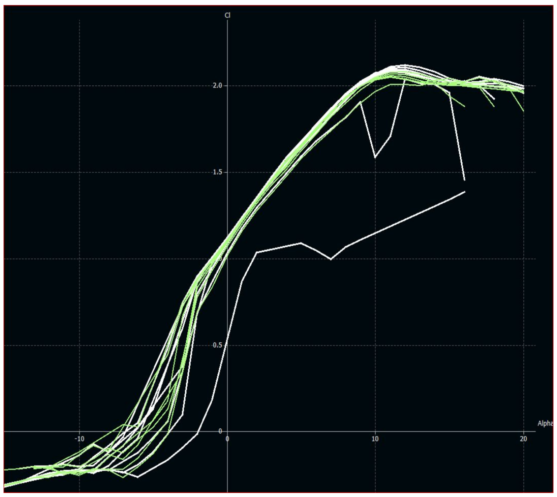
1. The RC should fly with an empty payload
2. Carry payloads internally, deliver them and return

3. The payload should be internally carried

3. AIRFOIL SELECTION

a) We initially consider airfoils that will have favorable characteristics in the conditions at which our plane will operate. Using this, we narrowed the number of airfoils down to 4, namely GOE 525, S 1223, S 1210, FX 74-CL5-140.An analysis was carried out for these four foils.

b) The S1223 had the best lift characteristics and had a decent drag characteric too.But for Re values from 50k to 100k, it had a sharp drop in Cl value of about 0.5 at low angle of attacks. Above 100k Re, the dip does not occur and there is a considerable improvement in the lift character.



c) The S1210 has the second best lift characteristic. It doesn't show any noticeable dip as seen in the S1223 foil.So, we decided to interpolate the S1223 and the S1210 with different character percentages of both the foils.

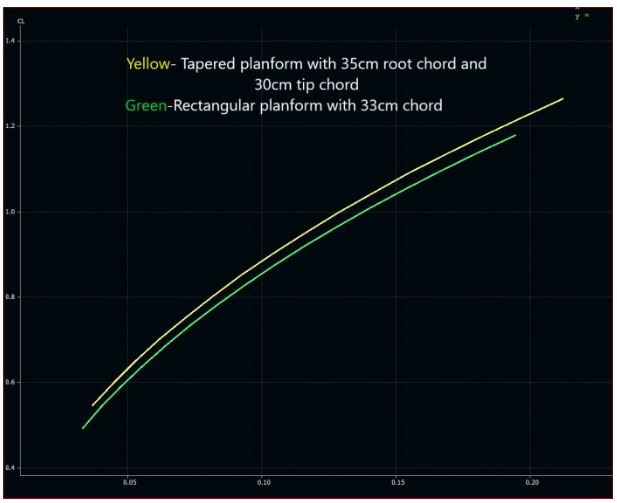
d) The sharp dip of the airfoils disappears only after 30% of S1223.But more the S1210 character, lesser the lift produced by the airfoil.So, 70% S1210 and 30% S1223 was concluded to be optimum.In fact, the 70%S1210 and 30%S1223 had the second best drag character.By modifying, the Cl dip disappeared and the drag character improved at the cost of small decrease in lift produced.

4. WING PLANFORM CONSIDERATIONS

With the selected interpolated airfoil, the planforms for the wings had to be considered. The primary requirement of the wing planform is to be able to produce enough lift to handle the dry weight and the payload. Though the elliptical planform is very efficient, we have not considered it owing to its manufacturing complexity. The forward and backward swept planforms were not chosen for iteration because of the problem of limited roll control of the aircraft as the ailerons would be at an angle to the relative airflow allowing us to use only the perpendicular component of the velocity of the wind which decreases the efficiency. Also, they are used for transonic and supersonic speeds.

All the planforms were iterated for different chord lengths between 20 cm to 35 cm with different offsets and different spans between 75cm in order to produce enough lift to support the empty weight and payload. An analysis was carried out in XFLR5 with a velocity of 11m/s and AoA of 3 degrees.

Type	Root Chord (cm)	Tip Chord (cm)	Coefficient of Lift(C_L)	Wing Area (m^2)	Lift (N)	Weight Carried (kg wt)
Rectangular	33	33	0.700	0.231	9.966	1.016
Forward (Trailing edge) Taper	35	30	0.708	0.227	9.853	1.004
Backward (Leading Edge Taper)	35	30	0.692	0.236	10.02	1.019
Double Taper	35	33	0.679	0.238	9.89	1.008



On comparing the values of weight, the Leading edge tapered planform produced the highest lift followed by the Rectangular and the trailing edge taper .Even though the rectangular planform gave a high lift, it generated a large amount of wing vortex/wing tip drag as compared to the other planforms due longer tip chord length. Overall, considering the highest sample lift produced by the backward tapered wing planform (as measured through XFLR5),lower wing tip vortices and subsequent vortex drag and the roll control advantages, the backward tapered airfoil was considered with the following features:

Root Chord	35cm	Coefficient of Lift(C_L) at 3 degrees alpha	0.756
Tip Chord	30cm	Span of the wing	75cm
Offset(Tip chord relative to Root Chord)	5cm	Area	0.244m^2

We decided to go with a **high wing configuration because of high ground clearance, shorter landing distance because of lesser impact of ground effect, Inherently stable since the center of mass is situated below the center of lift** and because we have used an angle of incidence of 3 degrees.

5. VELOCITY ESTIMATE, MOTOR AND PROPELLER CONFIGURATION

Estimation of the velocity is the primary task as it helps to decide on the Reynolds number to aid further analysis and to determine the motor and propeller configuration. $R_e = \frac{\rho \times v \times c}{\mu}$, where ρ=1.225kg/m^3, μ=1.81 $\times 10^{-5}$ kg/ms. The equation reduces to $R_e = 67679.59.56 \times v \times c$. To determine the velocity of the plane, we plotted the thrust and drag of the plane against the velocity. The values of drag were calculated using drag analysis in ansys. The Thrust Equation is

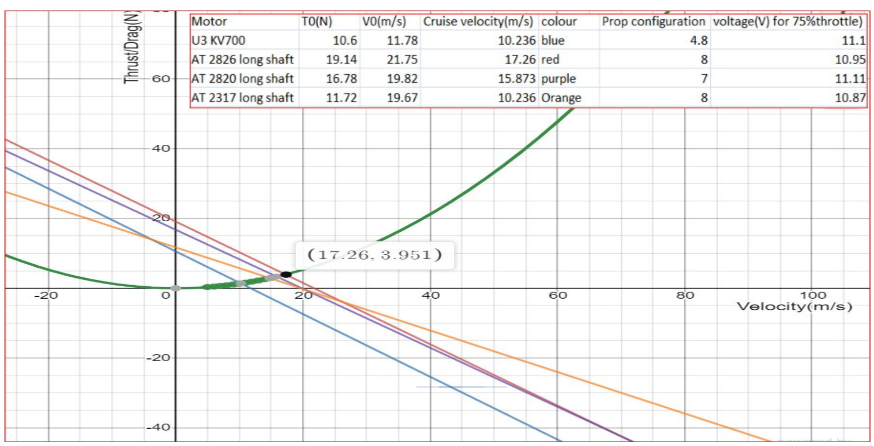
$$T(v, \omega) = \frac{1}{2}\rho A(0.7R\omega)(\sqrt{(0.7R\omega)^2 + v^2})\left(C_{L_o} + C_{L_\alpha}\left(\theta_p - \left(\frac{v}{0.7R\omega}\right)\right)\right)$$

And the drag equation is $D = \frac{1}{2} \times \rho \times v^2 \times C_d \times W_a$

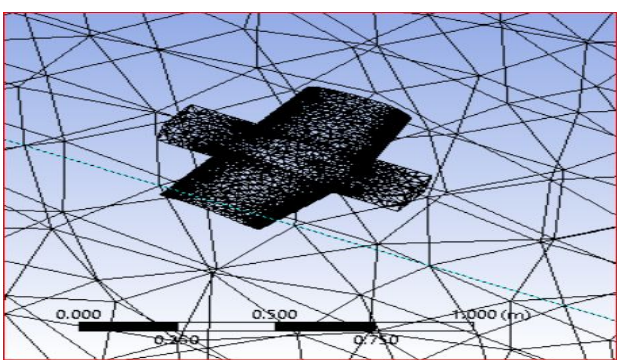
On plotting the above equation, we noticed that the variation of Dynamic Thrust with velocity of plane varied linearly. Hence we reduced the equation to a simpler form, given by the static thrust and the maximum velocity, which was determined using the propeller pitch and given RPM from the data sheet.

$\frac{T}{To} + \frac{v}{vo} = 1$ .We chose 4 motors and plotted the thrust against velocity. Using the ansys drag analysis, a drag vs velocity graph was also plotted on the same graph. **The point of intersection is the predicted velocity at which the aircraft should cruise from our analysis. Of all the four motors, the AT2620 gave the best cruise velocity.** So, we decided to choose the T-Motor AT2826 long shaft 900kV motor powered by a 2200mAh 3 cell battery. The pitch of the propeller is 8 inches

Velocity(m/s)	Drag(N)
5	-0.346
6	-0.487
7	-0.661
8	-0.873
9	-1.079
10	-1.331
11	-1.607
12	-1.91
13	-2.239
14	-2.593
15	-2.973



Motor	T0(N)	V0(m/s)	Cruise velocity(m/s)	colour	Prop configuration	voltage(V) for 75%throttle)
U3 KV700	10.6	11.78	10.236	blue	4.8	11.1
AT 2826 long shaft	19.14	21.75	17.26	red	8	10.95
AT 2820 long shaft	16.78	19.82	15.873	purple	7	11.11
AT 2317 long shaft	11.72	19.67	10.236	Orange	8	10.87



Propeller	Throttle	Voltage (V)	Current (A)	Power (W)	RPM	Torque (N*m)	Thrust (g)	Efficiency (g/W)
APC 15*8	40%	11.34	8.92	101.10	3745	0.188	921	9.11
	45%	11.31	10.56	119.50	3949	0.210	1030	8.62
	50%	11.28	12.69	143.14	4182	0.239	1168	8.16
	55%	11.23	15.35	172.38	4465	0.269	1328	7.70
	60%	11.17	19.17	214.08	4805	0.312	1534	7.17
	65%	11.10	23.09	256.38	5095	0.354	1730	6.75
	70%	11.04	27.02	298.20	5372	0.393	1914	6.42
	75%	10.95	32.45	355.28	5650	0.441	2140	6.02
	80%	10.88	36.74	399.67	5879	0.476	2317	5.80
	90%	10.71	46.75	500.90	6277	0.557	2680	5.35
	100%	10.63	51.81	550.80	6424	0.592	2844	5.16

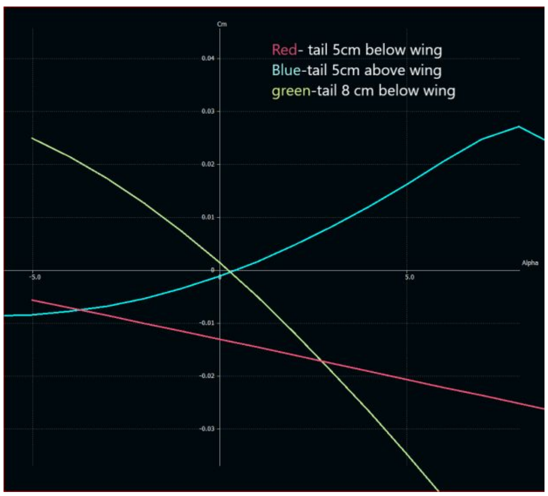
6. ASPECT RATIO

The Aspect ratio=(span x span)/wing area. Considering a very small span allowed, the aspect ratio had to be around 3 to get a good lift. So we decided to go with an aspect ratio of around 3. The span of the wing is 85cm (including the fuselage) and the area of the wing is 0.244 metre square. So the aspect ratio is 2.96 is taken.

7. TAIL CONFIGURATION AND EMPENNAGE DESIGN

1. Tail Configuration

The conventional and T-tail configurations were considered. Since we are going with a high wing configuration, it was a better option to go for conventional configuration. Nevertheless, we did XFLR analysis for both conventional and T-tail configurations. We fixed the distance of the leading edge of the horizontal stabilizer 60cm from the central leading edge of the wing to minimize the fuselage length. We had to get a negative slope for the Cm vs alpha graph along with a small but positive equilibrium angle and a static margin between 0.05 to 0.15. For an inertia of 1.9Kg and CoG location of 13.8cm, the T-tail's Cm vs alpha graph did not give a positive slope when placed at a height of 5cm above the tail. When placed 5cm below the wing, the equilibrium angle wasn't positive though the slope was negative. On the other hand, when the Horizontal Stabilizer was placed 8cm below the wing it gave a positive slope with equilibrium at 0.22 alpha.



$$S_m = \frac{X_{np} - X_{cg}}{MAC}$$ Xnp=18.3cm, Xcg=13.8, MAC=32.6cm

The Static margin=0.13 turned out within the limits of 0.05 to 0.15.

2. Rudder and VS sizing

Design outcome: the plane must be able to withstand a crosswind of 4m/s

Assumptions/Constraints: Rudder chord is assumed to be around 0.6 of the VS to ensure enough extra length at the tip chord for structural soundness. Maximum deflection of Rudder was 30 deg

Procedure: Analytic relations describing Rudder behaviour was taken from the paper: An Educational Rudder Sizing Algorithm for Utilization in Aircraft Design Software published in the International Journal of Applied Engineering Research.

$$C_{n_{\delta r}} = -C_{l_{\alpha_v}} \bar{V}_v \, \eta_v \, \tau_r \frac{b_r}{b_v} \quad (1)$$

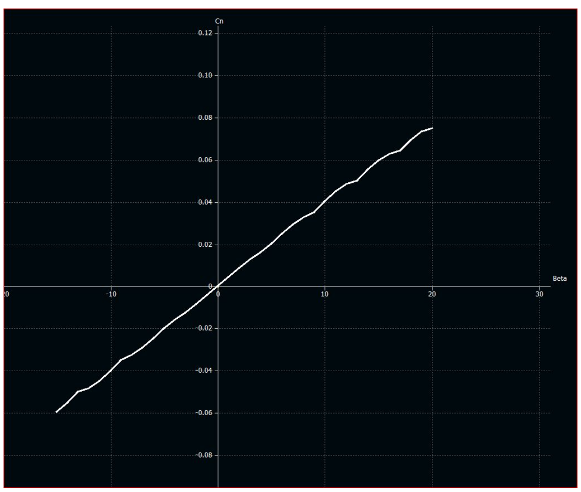
$$N_a = \bar{q} S b C_n \quad (2)$$

Using the above equations, we can determine the functions of the rudder as a function of the properties of the rudder and the vertical stabilizer. To compute the effects of the wind, an **ANSYS analysis is made where there is a crosswind of 4m/s when the glider is in steady flight condition on a model of the glider without the rudder**. This gives side drag of the glider. Using the side drag, we are able to calculate a VS-rudder combo that can keep the plane stable under such circumstances by analysing both the effects of the rudder and the influence of cross wind on the VS causing it to create a yawing moment.

3. Empennage design

a. Vertical Stabilizer and Rudder:

	Moments (n-m)		
Zone	Pressure	Viscous	Total
plane	0.38670844	0.040090533	0.42679898
Net	0.38670844	0.040090533	0.42679898



The rudder and the vertical stabilizer has been designed to overcome a max crosswind of 4m/s. This crosswind will cause a moment by interacting with the fuselage and the VS. The rudder has to be designed so as to counter the crosswinds. The relative size of the rudder is assumed with respect to the VS which reduces the variable to one which is the area of the rudder. The rudder span has turned out to be 19cm and chord length 8.1 cm. The aspect ratio of the VS was assumed to be 1.5 and the ratio of the rudder chord and VS chord is 0.6 which gives the VS dimensions of 20cm span, 16cm root chord and 11cm tip chord. The Vertical tail volume, 0.06, also had turned within the limits. The Cn vs beta graph plotted using XFLR has a positive yaw stability which confirms stability.

b. Horizontal Stabilizer and elevator:

While designing the Horizontal Stabilizer, we made use of thumb rules such as the area of the horizontal stabilizer should be around 25% of the wing area, which is in the higher range of the thumb rule as we wanted to minimize fuselage length which would lower weight. To minimize the effects of wing vortices, we chose an elevator with a lower aspect ratio and on using the Tail volume constraint we made an initial estimate of the HS, which we tweaked to get a stable configuration. The final dimensions of the HS are: a chord of 15 cm and a span of 41 cm. The area of the horizontal stabilizer turned out to be 615 cm^2 which is 25.2% the wing area. The HS is placed at 60cm from the central leading edge of the wing and 8cm below. We used the NACA 0009 airfoil to design the airfoil. **The use of an airfoil and the placing of the HS below the plane of the wing was to minimise the effect of wingtip vortices which could affect the stability of the glider.** For the elevator sizing, the thumb rule of 25% HS area and 0.2-0.3 times the chord of the HS has been followed. So the dimension we got for the elevator is 39cm span and 4cm chord.

8. AILERON SIZING

Design outcome: aileron activation must cause the plane to rotate 1 radian in 1 second

Constraints/Assumptions: Maximum angle of aileron deflection is 30 degrees, the ratio of aileron width to MAC of the plane is 0.25, the aileron will be located at the tip of the span to maximise moment.

Procedure: An Analytic equation was developed that described the angle rotated as a function of time and aileron deflection. This equation is valid under the assumption that the roll resistance of the aircraft is directly proportional to the angular velocity which holds when velocity is much higher compared to the product of angular velocity and half-span.

$$\Theta = \frac{K_{ail}}{K_{gli}}t - \frac{K_{ail}I}{K_{gli}^2}\left(1 - e^{-\frac{K_{pla}}{I}t}\right) \qquad (1)$$

K_{ail} – Aileron dependent constant, which is derived from the relation given below, from the paper Programmable Aileron Sizing Algorithm for use in preliminary aircraft design software, Published in the journal of engineering and applied sciences.

$$C_{l_{\delta_a}} = \frac{C_{L\alpha_w}\tau_a C_r}{Sb}\left[\frac{y^2}{2} + \frac{2}{3}\left(\frac{\lambda-1}{b}\right)y^2\right]_{y_i}^{y_0} \qquad (2)$$

K_{gli} – Glider dependent constant, is the proportionality constant between the roll resistance of the glider and the angular velocity. Computed by hand assuming a radial variation of angle of attack across all surfaces and an extra component was added for the fuselage.

I – Moment of Inertia of the plane about the roll axis. Computed using Solidworks.

$$Kail = \frac{\theta}{\frac{t}{K_i} - \frac{I}{K_i^2}(1 - e^{\frac{-K1}{I}}t)}$$

$$K_{ail} = \frac{\frac{1}{2\rho v^2 C_l \delta_{ail} \tau a C r}}{b}\left(\frac{1}{2} + \frac{2(\frac{\lambda-1}{b})}{3}\right)(y_0{}^2 - y_i{}^2)$$

By substituting required values in (1) we can solve for the required value of K_{ail} and using (2) we can find the inboard location of the aileron assuming tip of span to be outboard position hence solving for aileron size.

All required constants were either present in the paper or were computed from Xflr5

9. SERVO SIZING

The proper servo must be selected to ensure the function of all control surfaces . Each surface experiences a different amount of force , so each servo needs to be sized according to its respective control surface. Torque calculations are dependent on the control surface chord C,velocity V, control surface length L,maximum control surface deflectionS1, and max servo deflection S2. The below Equation outlines the appropriate torque calculations for the servo sizing .

$$T(oz-in) = 8.56x10^{-6}\left(\frac{C^2V^2L\sin(S_1)}{\tan(S_2)}\right)$$

The above equation generates torque values for the ailerons , elevators, and rudder as 15.028oz-in, 8.860oz-in, and 7.525 oz-in respectively, and these torque values are under the limits of the servo.

8. PAYLOAD CONSIDERATIONS, OPTIMIZATIONS AND PAYLOAD BOX

Two factors were considered while deciding the appropriate dimensions of the payload carrier box: the additional weight due to payload and its carrier box as well as the higher field score possible(Based on the flight score equation given by Eqn. 1

$$\text{Flight Score}= 75 \text{ x } 2^{\frac{1}{5}\left[1-\text{Max}\left\{\frac{l+b}{4 \text{ x } C},\frac{3(l+b)}{4 \text{ x } S}\right\}\right]}$$

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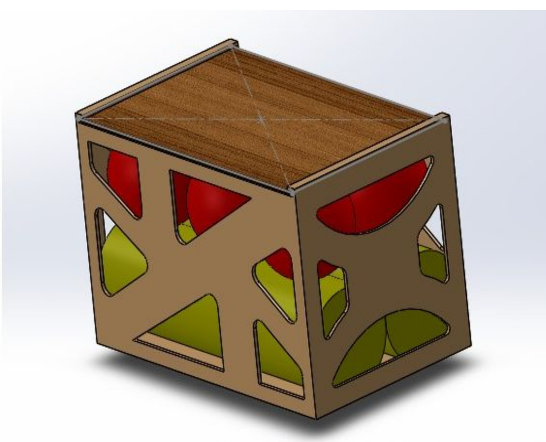
A 13 x 13 x 13 cubic sized aeroply shelled box was considered as the biggest possible box possible and several combinations



of dimensions and number of spheres and cylinders were tried out. Since the field score required a considerably lower top viewed area with more weight carried an optimization chart was created.From this the internal dimensions of the payload box were identified to be 12.7 mm x 80 mm x 80 mm.This provided an optimum balance between low weight and a considerably higher point score. This provided room for 2 cylinders and 6 spheres of the given dimensions thus allowing a total payload weight of 480 grams

Dimensions of payload			Contents			score factors		
length	width	height	cylinders	spheres	total payload	power	exponent	pred score
13	13	12	5	12	1080	-0.125	0.917004	68.775303
13	13	8	3	9	720	-0.2333333	0.850667	63.800037
13	9	8	2	6	480	-0.35	0.784584	58.843807
13	9	12	4	6	720	-0.35	0.784584	58.843807

Sections of payload optimisation

(Showing variations of weight and score)

Furthermore in order to facilitate easy loading and unloading of the medicines the box has a slidable lid like mechanism made from 1.5 mm aeroply This gives a payload box of net outer dimensions 130 mmx83mmx85mm.

The rectangular side faces of the box have further been modified to consider impact and stress applications. The 83 x 85 mm face has been cut into a typical I-shaped beam in order to hold any impact in the vertical direction and the sideward stress in the horizontal direction.**The rectangular 130 x 85 mm faces have been cut according to a diagonalised I-beam where stress concentration occurs on the centre beam, any stress in the vertical or horizontal directions are transferred through the branches to the central diagonal which then holds the extra stress without causing buckling and fracture**.

The overall surface will be covered with monocot to prevent any kind of exposition to any place outside.

10. WING ASSEMBLY AND AILERON STRUCTURE

As mentioned earlier the overall wing structure uses an interpolated airfoil(70% S1210 and 30% S1223) and follows a backward taper with negligible sweep.In order to maintain a slightly lower weight and at the same time to ensure strength and sturdiness to the wing , the general wing structure is made with custom cut airfoil plates having an optimised surface which ensures that each airfoil pad provides the least weight possible along with proper stress handling while continually ensuring a laminar ,streamlined flow. The so formed structure will be covered with monocot for appropriate packing and flow.

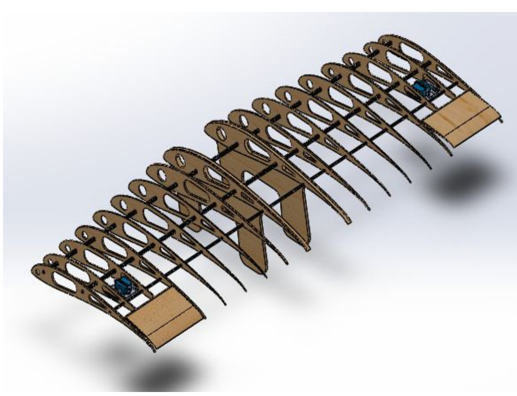


Figure 8

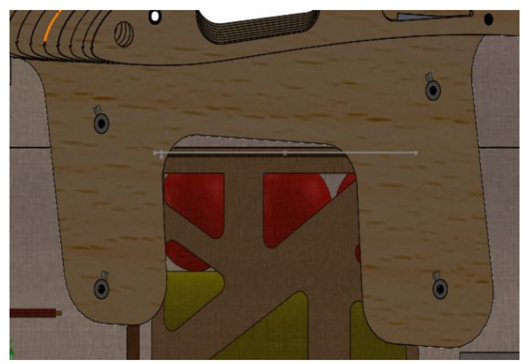
The airfoil pads have varying thickness based on stress concentration.In this accord,the tip and root airfoils are made thicker at 3mm at tip while 9mm at the chord while the other airfoils are 2 mm thick.This ensure sturdy structure with a low chance of fracture.

The airfoil pads are kept in place using carbon fibre rods.As can be seen from the fig. the 2 forward CF rods are 6mm in diameter while the third is 3mm of the same.these are glued to all the airfoil pads and the required distances to ensure a linear taper backwards.

The aileron control surface uses 1/3rd of the wing span and has a chord length of 8cm.It follows a rectangular planform The ailerons have internal ribs similar to the wing which ensures stability.

The aileron is supported by a 2.5mm diameter CF rod on both sides of the aileron and glued into pockets created on the wing pads on either side of the sidewards airfoil pads.As the aileron holes are 3mm wide they allow free rotation along the rod.

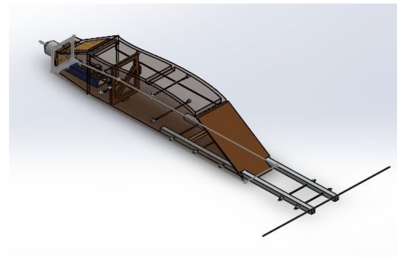
The root chords are modified in such a way that they can be easily attached to the fuselage body through the top thus forming a top winged aircraft.the protrusions on either side are 4.5mm thick. This allows the remaining 4.5 mm of the airfoil to rest on the top of the fuselage while the protrusions lie on the side of the fuselage which are then connected to the fuselage through 3mm CF rods.These rods are fastened using 5-3 x 7mm ring fasteners on either side of the fuselage which prevent the lateral movement of the rods,thus ensuring the wing to be stable in place while at the same time replaceable.In this manner, any repair to the wing can be made simpler simply by removing the CF rods and modifying the wing.This further helps in packing.



11. FUSELAGE STRUCTURE AND DOUBLE BOOM

The fuselage has a tapered structure in general.The load carrying section of the fuselage has the highest volume with 3 straight edges and the top surface following the curve of the airfoil as mentioned in the wing before such that the net curve.The upper surface at the high volume point is modified such that there is enough room to hold the wing structure but at the same time reducing material weight.

The structure at either side of the high volume area follows a taper downwards in order to reduce surface and profile drag.Furthermore, the front taper is such that it blends in with the wing boundary when the wing structure is placed on the fuselage.This allows smooth flow of air around the upper boundary. This tapered surface has a hinged door for allowing the starting and the stopping of the battery and the circuit.



The back taper to the fuselage is connected to a hinged door which allows the easy loading and unloading of the payload box and its elements.

The front taper ends with a motor mount having a plated wall at one end.The motor mentioned earlier is fitted into this wall and supported through the mount such that the motor stays in position due to self torque.

The fuselage is supported in the front with a trussed wall to handle stress concentration.

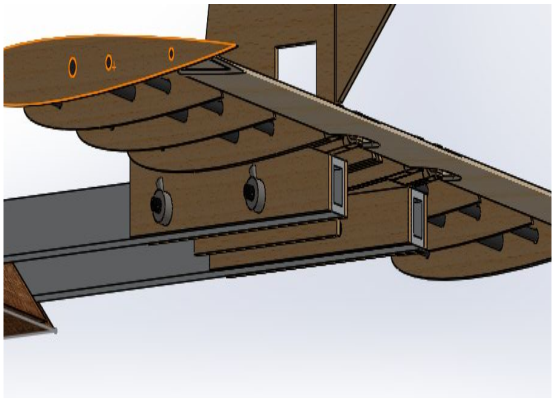
At the end of the payload box,the fuselage is connected to 1cm x 1cm aluminium rods passing through the back door and forming a double boom structure.These rods are supported by three lateral CF rods which are fastened with the fuselage on the outer surface.

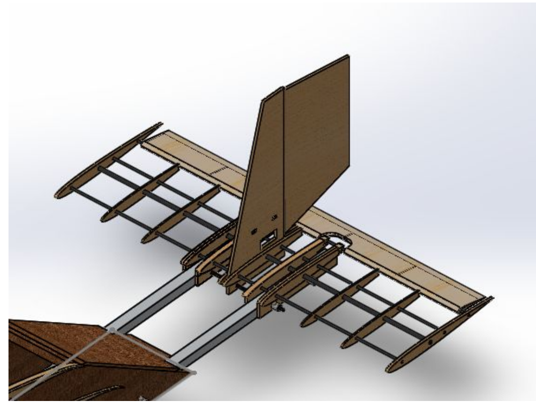
These booms act as support for the empennage structure including the control surface movement. Furthermore, they help decrease the necessary mass which would otherwise be required for the empennage attachment. In order to maintain the gap between the boom so as to not affect the empennage structure the fuselage is fitted with two 1cm x1cm balsa rods which are to be glued at 2 positions along the booms ,inside the fuselage.

12. EMPENNAGE STRUCTURE DETAILS

Horizontal Stabilizer :

15 cm chord and span is 41 cm,Material used to construct the structure of HS : Balsa,Carbon Rods of length=41cm positioned at 2cm(3mm diameter),6cm(4mm diameter) and 8cm(3mm diameter) from the leading edge of horizontal stabilizer .The empennage is attached to the double booms coming out of the fuselage using an extrusion from the horizontal stabilizers,carbon rods and fasteners.Elevator Dimensions : 4cm(Chord) and 39cm(span).Material used for Elevator = Balsa. The elevator is designed similar to the ailerons and is connected to the horizontal stabilizer using a carbon rod of 1mm diameter and 41cm length.



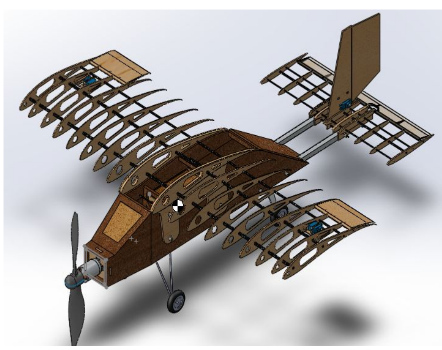


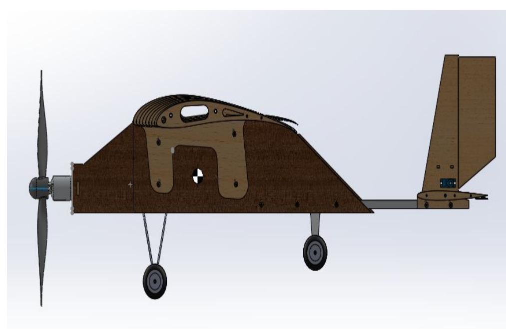
Vertical stabilizer:

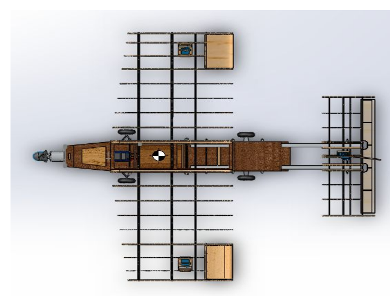
Dimensions of Vertical stabilizer:Root Chord=16cm,Tip chord=11cm,span=20cm. Vertical stabilizer material : balsa.Vertical stabilizers connected at the root to the horizontal stabilizers using the carbon rods of horizontal stabilizer.

Rudder dimensions Chord length: 8.1 cm length 19cm, and it is connected to the vertical stabilizer using a 2.5 mm carbon rod.

13. OVERALL PLANE STRUCTURE



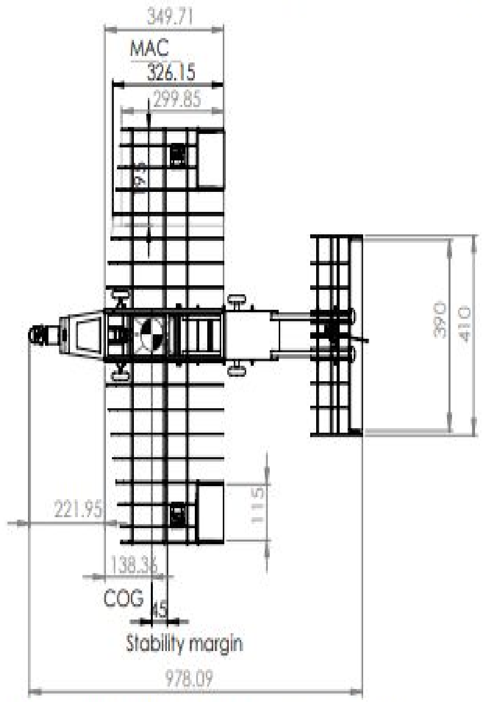




14. TABLE OF ACRONYMS,FIGURES, REFERENCES

Symbol	Meaning	Used in
ρ	Density of Air	Velocity estimation
v	Velocity of plane in still air	Velocity estimation
μ	Dynamic Viscosity of air	Velocity estimation
ω	Angular velocity of propeller	Velocity estimation
R	Radius of the propeller	Velocity estimation
C_{L_0}	Coefficient of lift at 0 AoA	Velocity estimation
C_{L_α}	Coefficient of lift at α AoA	Velocity estimation
θ_p	Pitch of the propeller	Velocity estimation
C_d	Coefficient of drag	Velocity estimation
W_a	Area of the wing	Velocity estimation
D	Drag	Velocity estimation
T	Thrust	Velocity estimation
τ_a	Aileron size parameter	Aileron sizing
C_r	Root Chord of wing	Aileron sizing
S	Area of the wing	Aileron sizing
b	Span of wing	Aileron sizing
y_0	outboard coordinate	Aileron sizing
y_1	inboard coordinate	Aileron sizing
$C_{L\alpha_V}$	Cl slope of rudder	Rudder sizing
V_v	Vertical tail volume	Rudder sizing
τ_r	Rudder size parameter	Rudder sizing
b_r	Rudder span	Rudder sizing
b_v	Vertical tail span	Rudder sizing
S_m	Static Margin	Tail Configuration
X_{np}	Position Of neutral point	Tail Configuration
X_{cg}	Position of CG	Tail Configuration
MAC	Mean aerodynamic chord	Tail Configuration

Refrence
An Aerodynamic Comparative Analysis of Airfoils for Low-Speed Aircrafts, Sumit Sharma
International Journal of Engineering and Technical Research

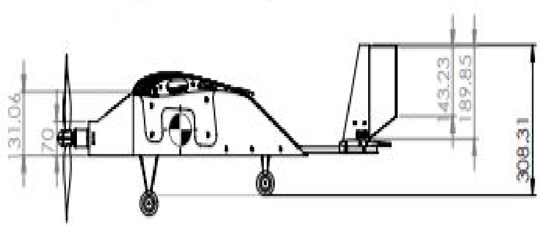


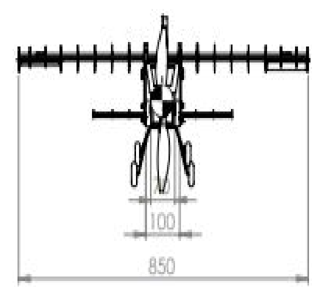
COG of Empty and loaded plane are coincident

Summary data	
Winngspan	8.50 cm
Empty Weight	1.307 kg
Battery Capacity	2200 mAh 3s
Motor Make	T-MOTOR
Motor Model	AT2826
Motor KV rating	900
Propeller Manufacturer	APC
Propeller Diameter	8 inch
Propeller pitch	5 inch
Servo manufacturer	Tower Pro
Servo model number	SG90 9 g
Servo torque specs	1800g.cm

Weight and Balance

Component	Force(Newtons)	Moment arm(inch)	Moment(N*inch)
Motor	1.717	10.297	17.679
Battery	1.815	5.253	9.534
Payload	5.003	0	0(coincident with COG)
ESC	0.343	4.259	1.461
Receiver	0.147	4.942	0.726





Final drawing

A3

15. TECHNICAL DATA SHEET: EMPTY WEIGHT BUILD-UP

Team Name:The Third Dimension 1

School Name:National Institute of Technology,Tiruchirappalli (NITT)

Team Number:AD-001

SL	Part	Weight(g)
1	Fuselage(Aeroply)	171.58
2	Front door(Bals	3.91
3	Propeller	86
4	Front motor	175
5	Motor base plate	9.01
6	Battery	185
7	ESC	35
8	Receiver	15
9	Landing Gear	36.53
10	Wheels	12
11	Front wall(Aeroply)	4.66
12	Back door(Aeroply)	8.73
13	Aluminium rod	115.72
14	Boom Support Structure(Balsa)	1.74
15	End fastener(Aluminium)	18
16	Fastening cf rod 3mm (120)	13.23
17	Servos	60
18	Wing servo mount(Balsa)	3.86
19	Wing ribs(Aeroply)	189.87
20	Aileron(Aeroply Ribs + Balsa surface)	16.42
21	Wing cf rod	46.78
22	Wing cf rod 3mm	18.72
23	Aileron cf	2.22
24	HS ribs(Balsa)	16.1
25	HS 3mm CF rod	7
26	HS 4mm CF rod	8.95
27	Elevator(Balsa)	4.13
28	Elevator cf rod(Balsa)	3.52
29	VS(Balsa)	4.914
30	Rudder(Balsa)	5.51
	Net Weight:	1279.12