Bursa Teknik Üniversitesi

LAGARI TEAM 2013

Tophane Teknik ve Endüstri Meslek Lisesi HAVACILIK KULÜBÜ

CARBON FIBER REINFORCED POLYMER BASED UAV SYSTEM DESIGNED FOR FFD 2013

ABSTRACT

Design and manufacturing stages of the UAV named Lagari are briefly explained in this presentation. Lagari is produced by the team of Tophane Technical &Industrial Vocational High School and Bursa Technical University and it took the 2nd place in the Future Flight Design competition 2013. Good performance of the Lagari in the competition can be attributed to the light weight design thank to the carbon fiber composite technology used in the body.

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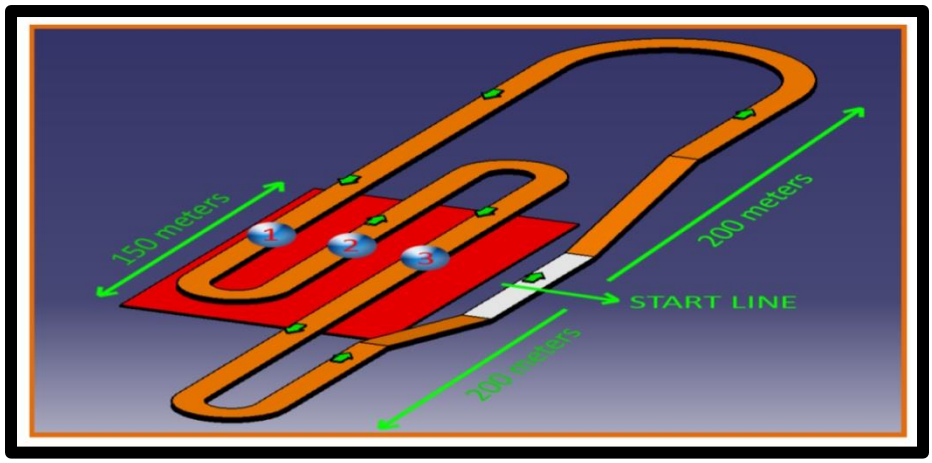
TEAM MEMBERS:

Murat Bozdemir: Team Leader Selçuk Gül: Pilot Hüseyin Lekesiz: Advisor
Gizem Şencan: Secretary Fatime Zehra Köse: Team Member, Public Relations
Batuhan Yılmaz, Alişah Simitçi, Bertay Binay, Necati Ertaş: Team Members, Design and Manufacturing

COMPETITION BRIEF AND MISSIONS

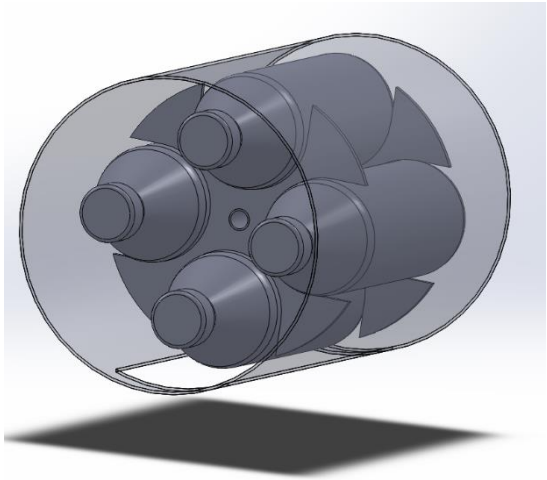


Missions are defined as following:

M1: The first mission includes a flight with 1-bottle payload.

M2: The second mission consists of a flight with 4-bottle payload.

M3: The third mission includes a flight with 3-bottle payload to the target area and dropping them in order inside the target area.



Overall score:

- written report score
- volume score
- total flight score. (summation of all three mission scores has the greatest weight on the overall score.)

Flight performance is evaluated based on the flight time and light-weightness of the vehicle.

DESIGN AND MANUFACTURING OF LAGARI

- *Conceptual Design Selection*
- *Preliminary design phase* (Wing area, wingspan, motor and gear box, battery type and quantity, propeller pitch and diameter)
- *Detail design* (Fuselage system design, wing assembly, storage case)
- *Manufacturing*
- *Assembly*
- *Testing*

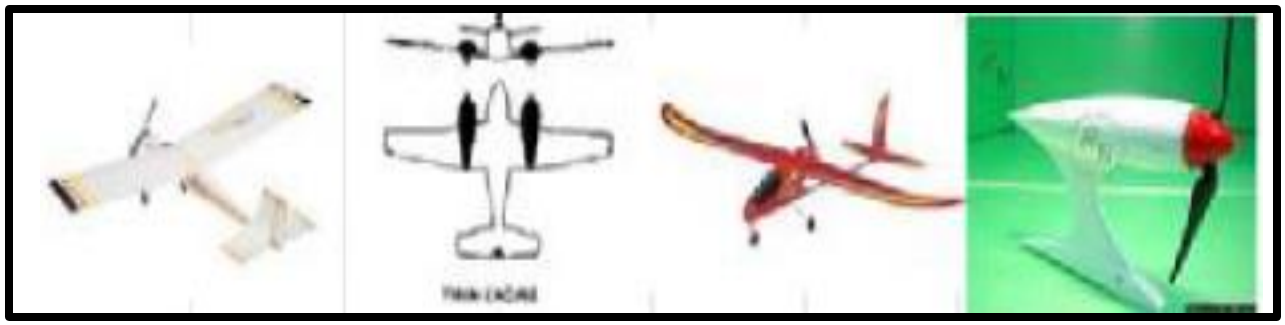
Conceptual Design Selection:

•Aircraft Configuration

Conventional Flying-wing Bi-plane Elliptical

- aerodynamic performance
- rapid manufacturing & assembly
- best system weight

- Motor &Propeller Location Selection



Twin Pusher Pod

❖ Single Motor and Propeller(front side)

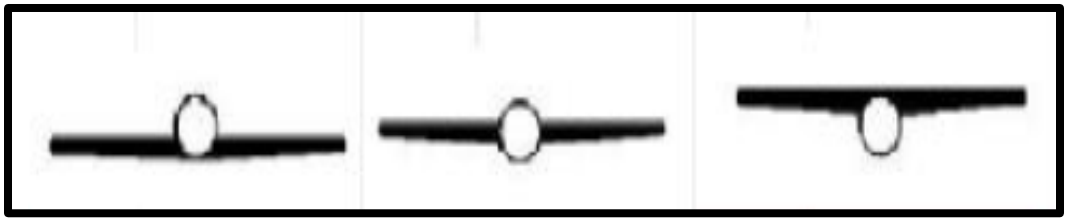
- better stability
- high efficiency of the propeller(blades rotation in undisturbed air)

- Empennage Configuration

Conventional | T-tail (vulnerable) | V-tail (difficult manuf.) | U-tail (heavy)

- reliable stability&control
- efficient weight values
- simple manufacturing
- stable movement ability

- Wing Placement Selection



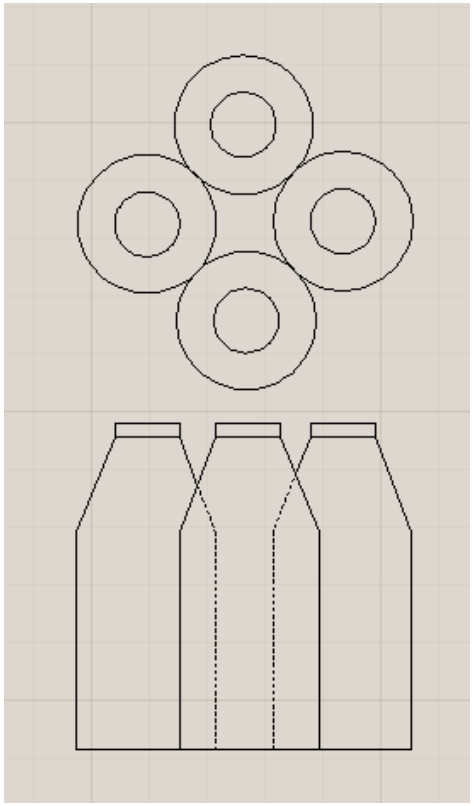
Log-wing Mid-wing High-wing

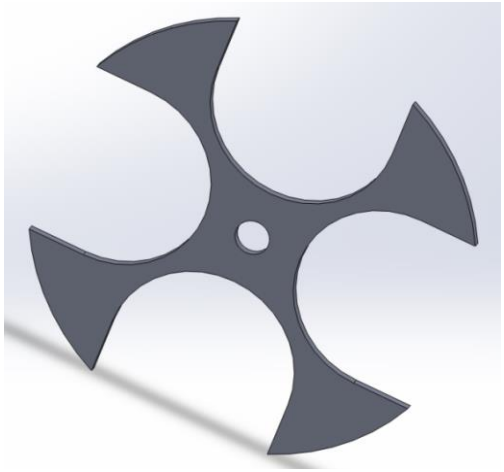
❖ High wing

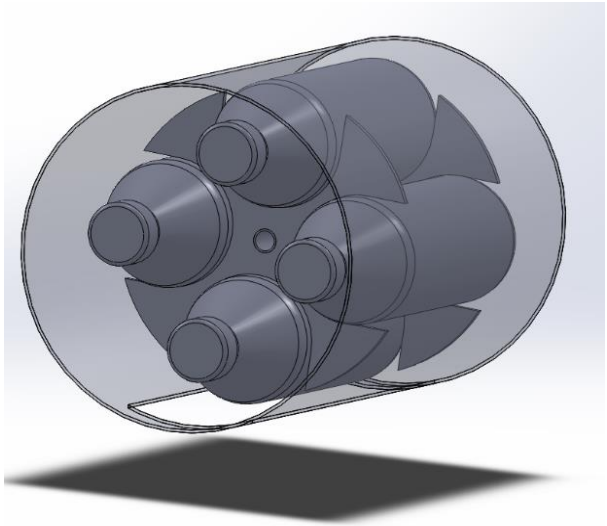
- better stability and durability
- loads transmission directly to the fuselage
- stronger joint between the wings and the fuselage

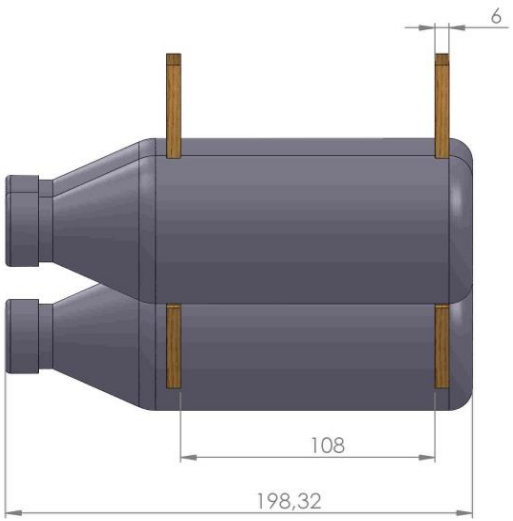
•Payload Configuration

- good rotary mechanism
- the loads can be released in the shortest time in a smooth manner





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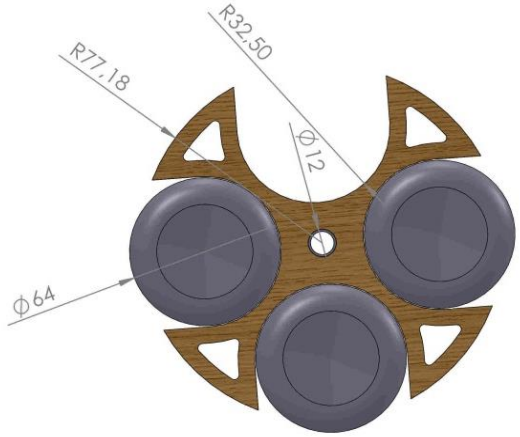
R32,50
R77,18
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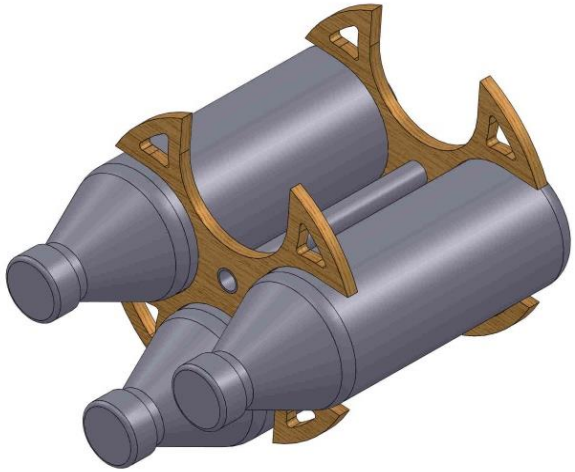
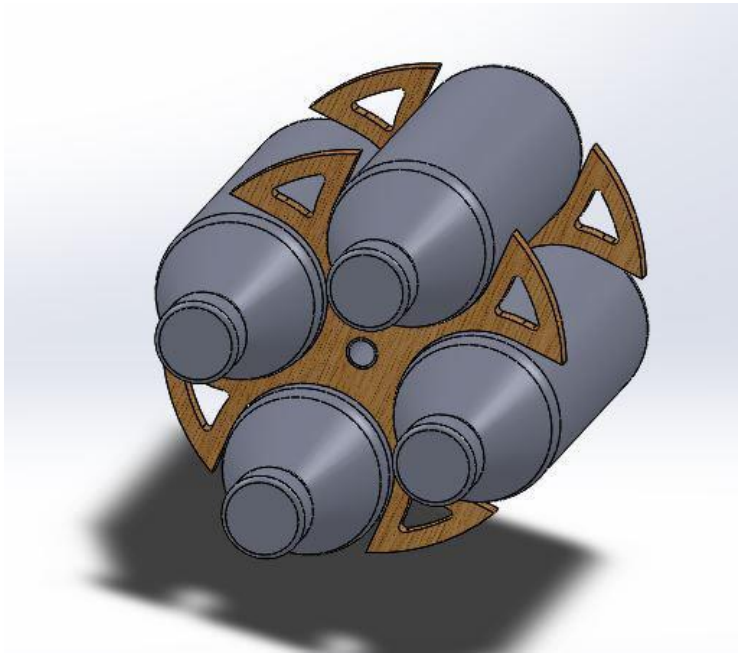




Preliminary design phase:

- Wing area

A larger wing area provides,

❖ a short take-off distance

❖ larger payload capacity

○ low-speed.

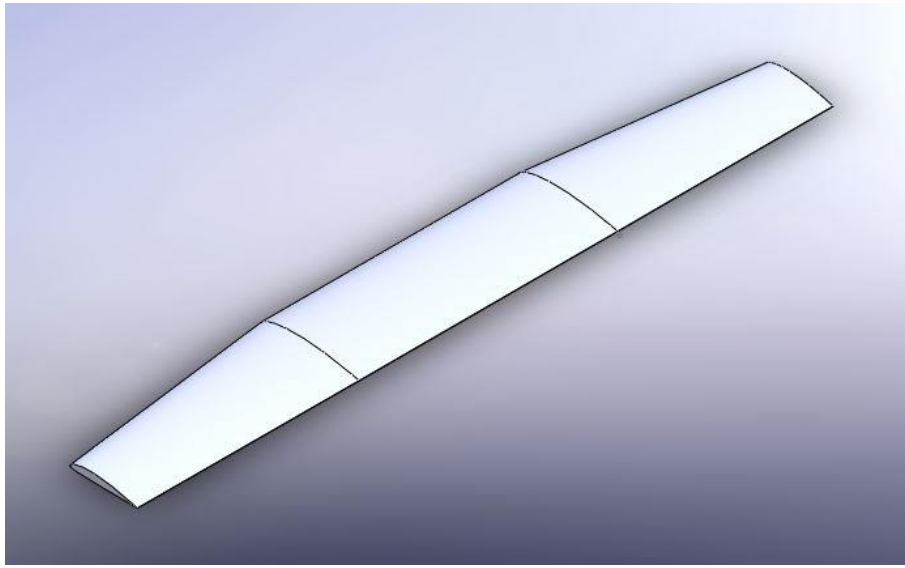
- Wingspans

Large wingspans provides,

❖greater efficiency

○ low cruise velocity.

• 10º dihedral angle



WING	
AIRFOIL	CLARK Y
SPAN (m)	2100
AREA (m^2)	0.59

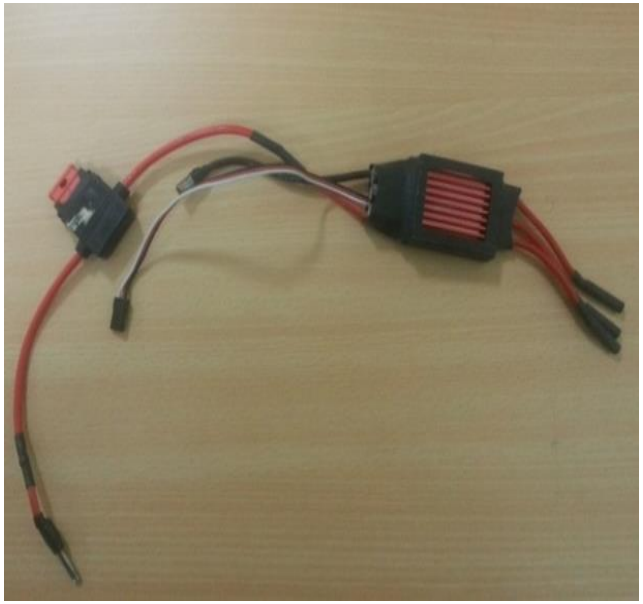
• Selection of the battery type and quantity requires balancing weight and performance.

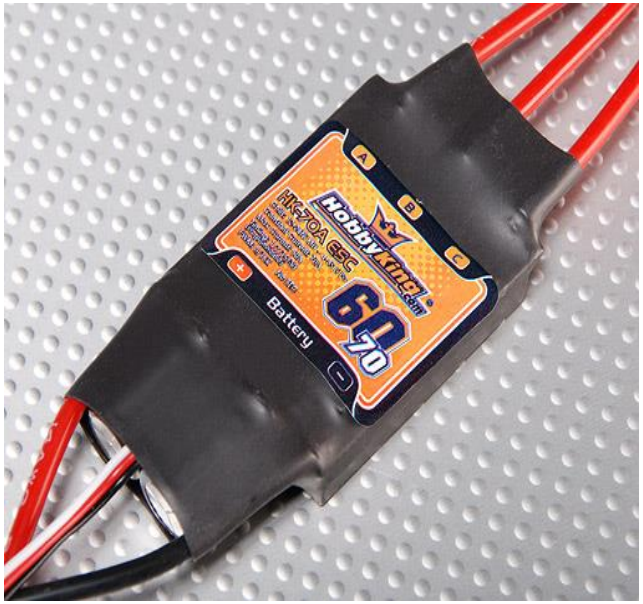
Minimum capacity	: **3000 mAh**
Configuration	:**4S1P / 14.8v / 4cell**
Constant discharge	: **20C**
Peak discharge(10sec)	:**30C**
Pack weight	: **337g**
Pack size	: **141 x 43 x 27mm**
Charge plug	: **JST-XH**
Discharge plug	: **4mm Bullet-connector**

• A high efficiency motor is desired, but it must provide other sizing requirements.

Model	: **TR42-60C**
Speed	: **500 Kv**
Max Efficiency	: **38A**
Max Load	: **50A**
Weight	: **280 g**
Lipo Cell Requirements	: **3~7 cell**
No Load current	: **4.3 A**
Resistance	: **23mH**
Power	: **900W**
Shaft	: **5mm**

- ESC (electronic speed control)



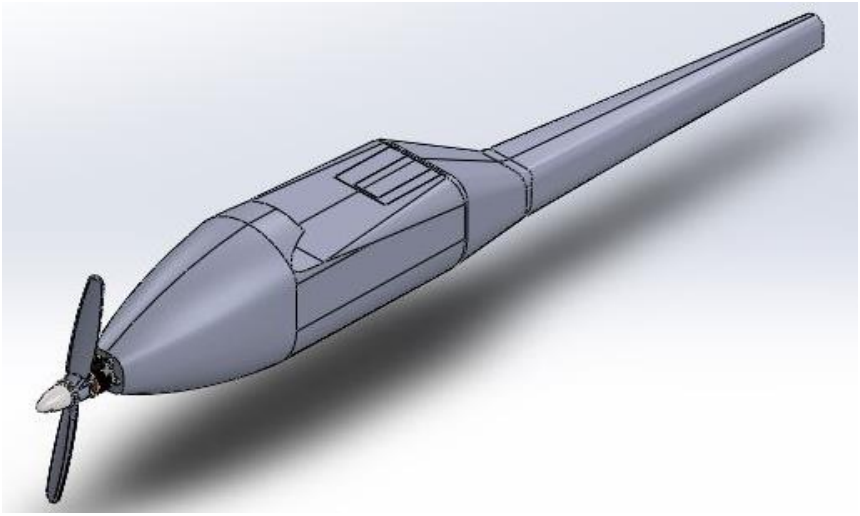


Weight	:63g
Size	: 55x35x8mm
Cells	: 12-24Ni MH ~ 4-8S Li Po
Max Current	: 60A
Burst	: 70A
Constant current	: 60A Max 70A
Li-Poly	: 4-8 cells

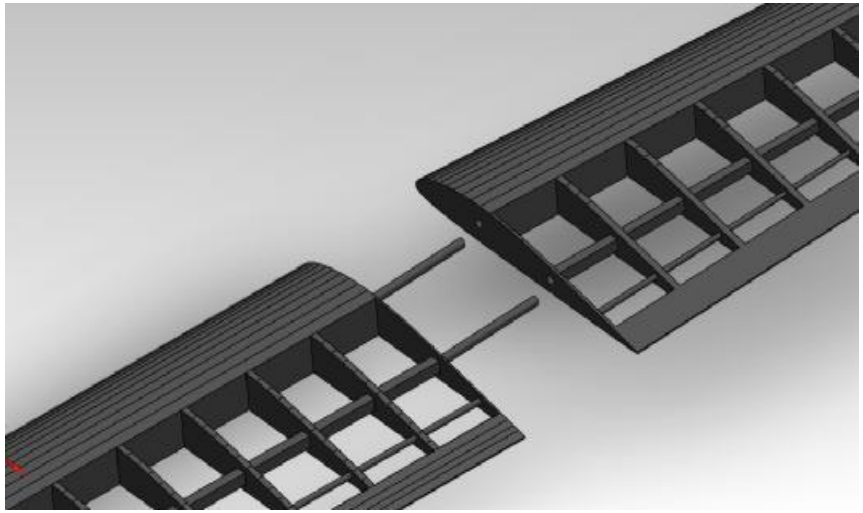
Detail design :

•*Fuselage system*

- best bottle placement (payload design)
- minimum weight (carbon fiber technology)
- minimum loading time (quick opening mechanism)

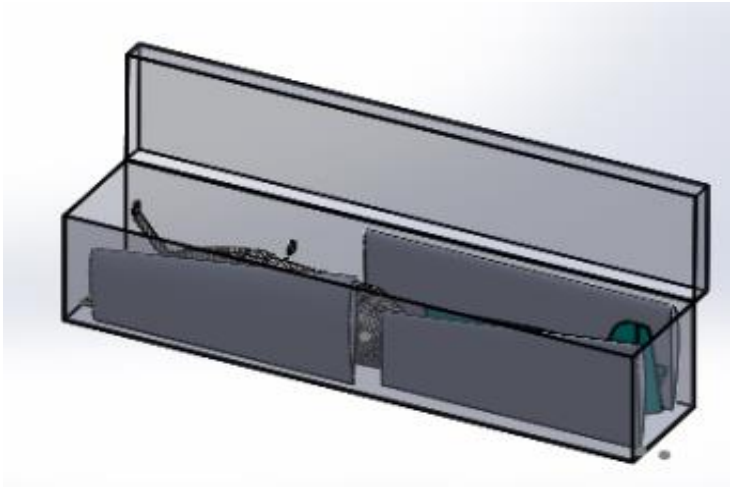


- *Wing assembly*



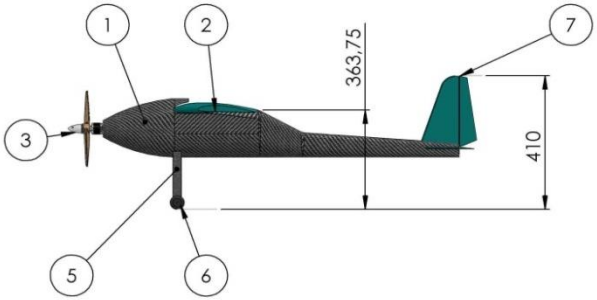
❖Double-pipe mechanism
-demountable
(to minimize the volume
of the storage case)

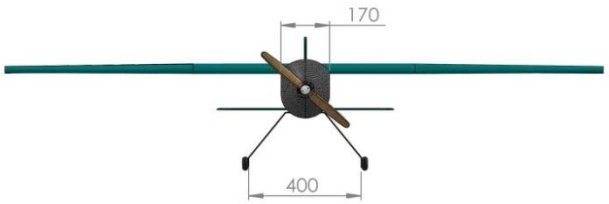
- *Storage case*

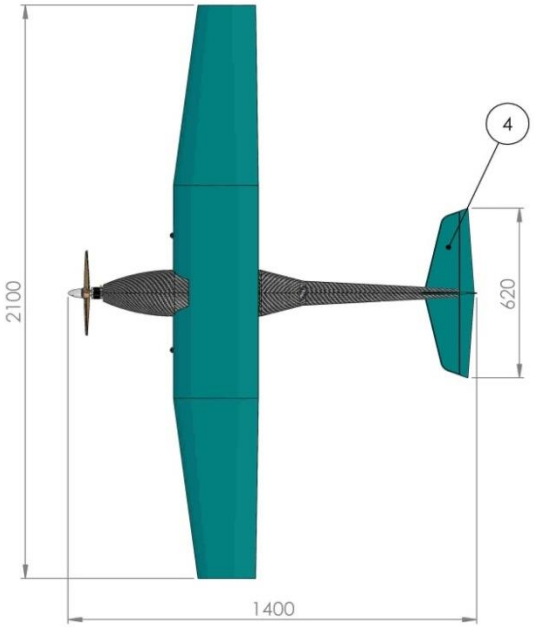


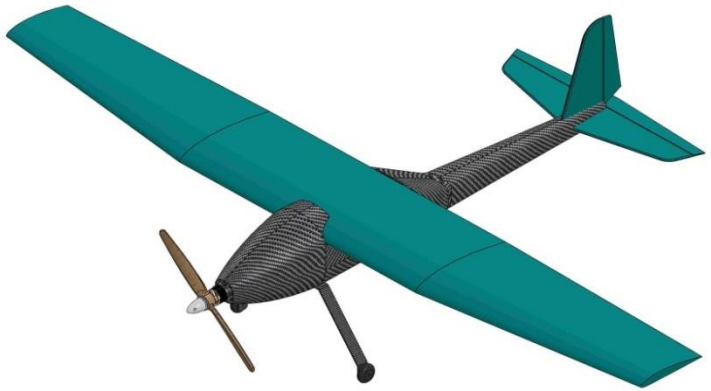
- must be light
- have an easy lock mechanism
- as minimum volume as possible

- *Final design of LAGARI*









ÖĞE NO.	PARÇA NUMARASI	TANIM	MİKT.
1	FUSELAGE		1
2	WING		1
3	MOTOR		1
4	ELEVATOR		1
5	LANDING GEAR		1
6	WHEEL		2
7	RUDDER		1

FUSELAGE		STORAGE CASE	
LENGTH (mm)	1400	1430	
WIDTH (mm)	170	300	
HEIGHT (mm)	410	420	
AIRCRAFT WEIGHT AND BALANCE		**WING**	
AIRFRAME (kg)	2,26	AIRFOIL	CLARK Y
MAXIMUM PAYLOAD (kg)	2	SPAN (m)	2100
MAXIMUM GROSS WEIGHT (kg)	4,26	AREA (m^2)	0.59

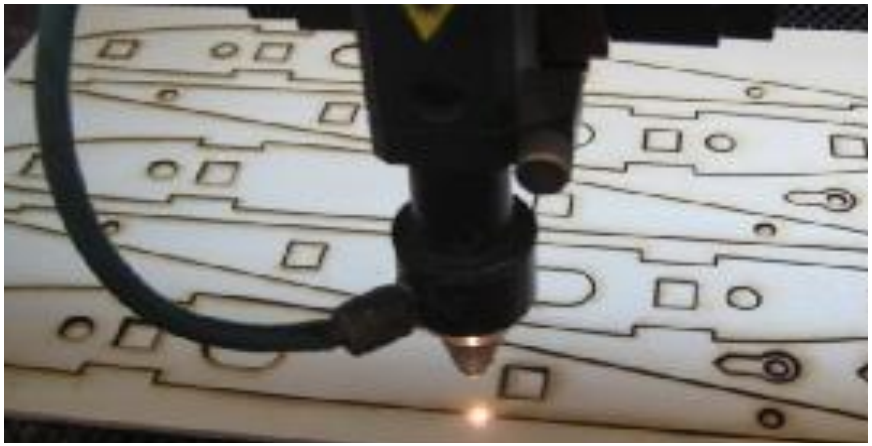
Manufacturing:

•*Wings and Empennage*

(Balsa material is used to produced.)

- being light
- ease of manufacturing
- low cost

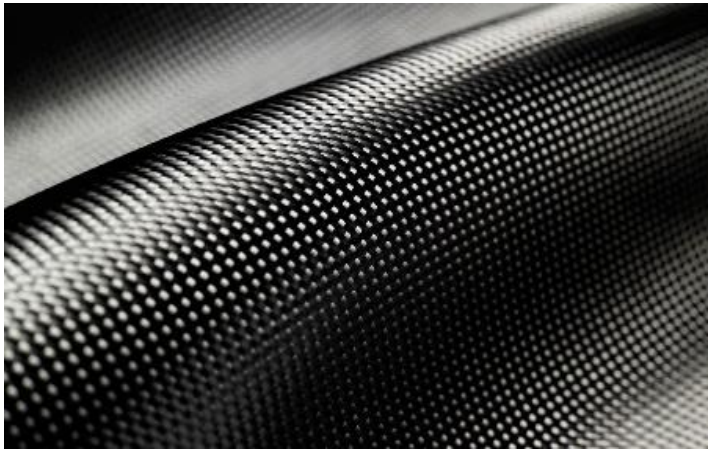
- Laser cutting of the wings and assembled by adhesive material

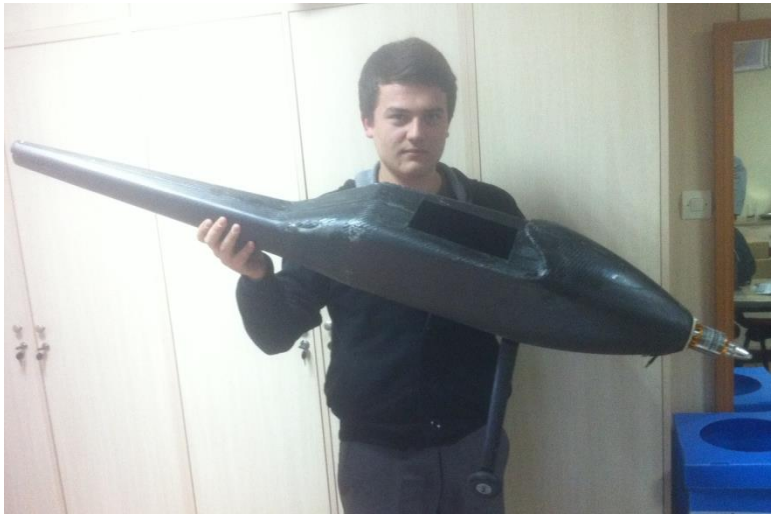


- Adhesive material for empennage (rudder & elevator)

•*Fuselage*

-Carbon fiber technology





- ❖ high stiffness (modulus of elasticity 138 GPa)
- ❖ high tensile strength (ultimate tensile strength 3.5 GPa)
- ❖ low weight
- ❖ high chemical resistance
- ❖ high temperature tolerance
- ❖ low thermal expansion

- usable in aerospace, civil engineering, military, and motorsports

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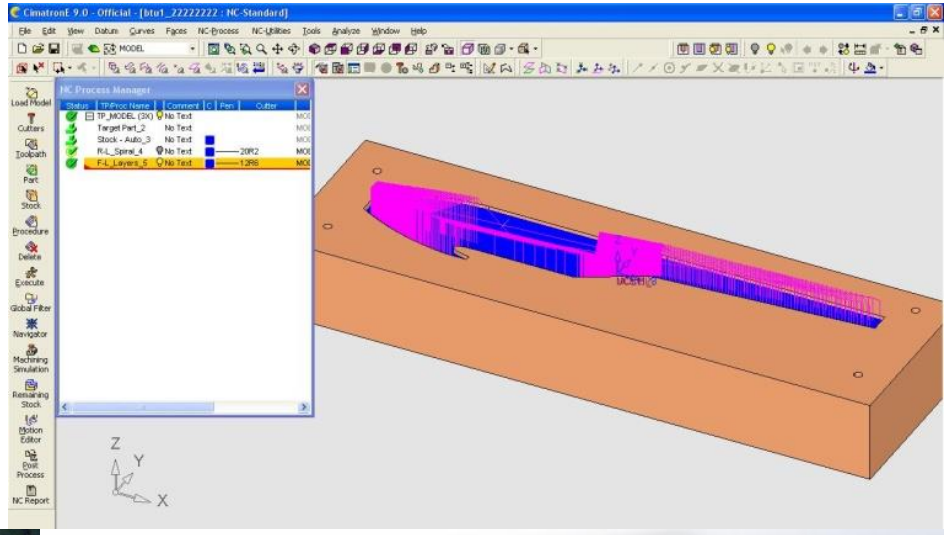
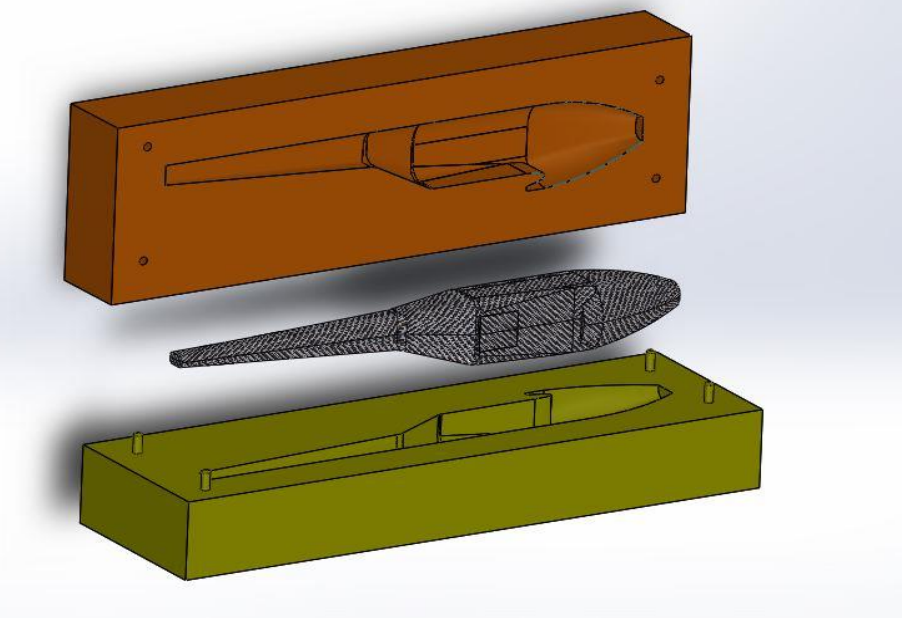
-Design and manufacturing the mold of the fuselage (Solidworks&CNC foam cutter)





- Sanding the mold and varnishing

- the inner surface of the mold was covered by carbon fiber fabric (200 g- HS 3K fabric)

- infusion process (epoxy to binding)

-vacuum
(to remove the air from the inside of the molds)

-hardening under 60ºC in furnace.

Assemble:

Testing:

-Structural Test
(25 kg without failure)

-Wing
- Propulsion
- Flight & Landing

FFD 2013 FINAL SCORES

The final scores for the first three is presented below:

Order	Team Title	Technical Report Score	Volume Score	Flight Scores			Modularity Factor (MF)	Total Score without MF	Total Score (TS)	TS * 100
				Mission I Score	Mission II Score	Mission III Score				
1	OTONOM AMUK	36	25.7	12.63	49.56	86.79	0.014	359.67	5.035	504
2	LAGARI	36.3	16.2	17.1	105.79	128.57	0.0122	303.96	3.708	371
3	AMUK	34.15	25.74	17.81	53.69	132.44	0.0128	263.83	3.377	338

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