Unmanned Aerial Vehicle

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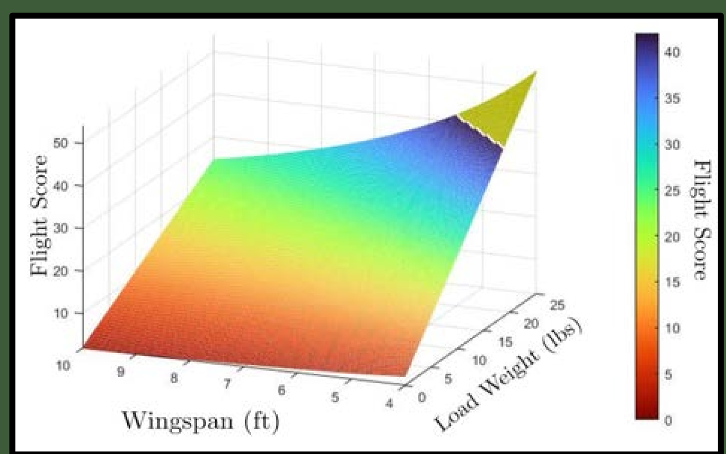
Challenge

Design and build a UAV that meets the SAE competition guidelines to achieve the highest score possible. The score is determined using the following equation:

$$\text{Flight Score} = \frac{3 * \#\text{ of Soccer Balls} + \text{Weight of Payload}}{\text{Wingspan} + (3 + \text{Cargo Bay Length} * \text{Diameter of Soccer Ball})}$$

The scoring equation was plotted to see which factors have the greatest effect on final score



Visualization of flight score with 1 soccer ball. Golden region in the top right corner would have won the 2021 competition.

A top score can be achieved by:

- Minimizing wing-span
- Maximizing the weight of the payload
- Carrying one soccer ball

Additionally, the plane must be functional, safe and legal. Input from local RC airplane experts, manufacturers and the FAA was incorporated into the design requirements.

Concepts

Using the design requirements as a guide, hundreds of ideas were generated

# of Wings	Wing Shape	Chord Length	Wing Orientation	Wing Tips	Control System	Unconventional
1	Straight	Short	Forward Sweep	Upswept	Traditional	Channel wing
2	Tapered	Medium	Back Sweep	Downswept	Thrust vectoring	Conveyor belt
3	Curved	Long	Straight	Wing Plate		Accoustic Attachment
4			Stacked	Dual Sweep		Flow Injection

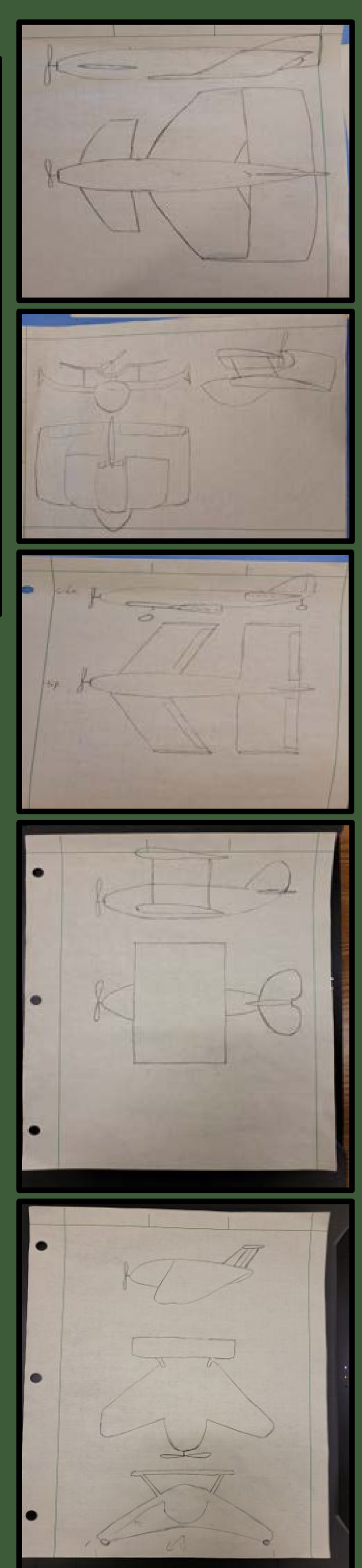
Chart used to generate high lift plane designs

Selection criteria were determined and weighted to ensure the best design was chosen. Ability to create lift is most critical. Cost effectiveness was less important.

Scoring Matrix

Selection Criteria	Weight	A	B	C	D	E	F	G	Control	Legend	
		Concepts									
Lift Area	10	3	2	2	1	3	1	2	0	Control	Bush Plane
Easy to Manufacture	4	0	-2	0	0	1	-1	0	0	A	SkyCandy
Easy to control	7	0	-1	0	0	-1	-1	0	0	B	Penguin
Cost Effective	3	0	-1	0	0	-1	0	0	0	C	F&B
Durability	6	3	2	-1	0	-1	3	2	0	D	MidWing
Easy to repair	3	0	-1	0	0	-1	-1	0	0	E	3FW
										F	Ground Effect
Net Score		48	11	14	10	15	14	32	0	G	Bi plane
Rank		1	5	4	6	3	4	2	NA		

Scoring matrix used on final 7 designs



Sample of concepts

Prototyping and Analysis

The scoring matrix dictated the final models to be the above designs. Both were modeled with foamboard for flight testing at 1/2 scale.

Weighted Flight Test Results:

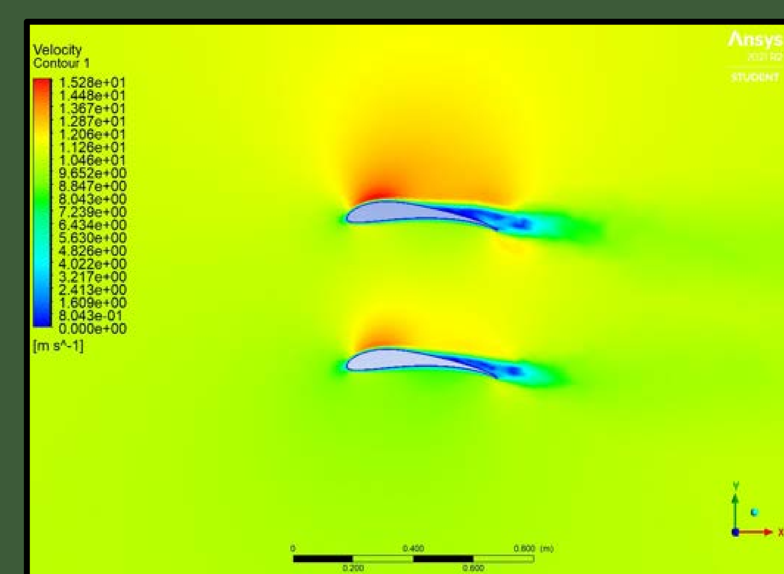
- Skycandy (left): 0.5 lbs.
- Biplane (right): 1.5 lbs.

Predicted Full Scale Payload Weight

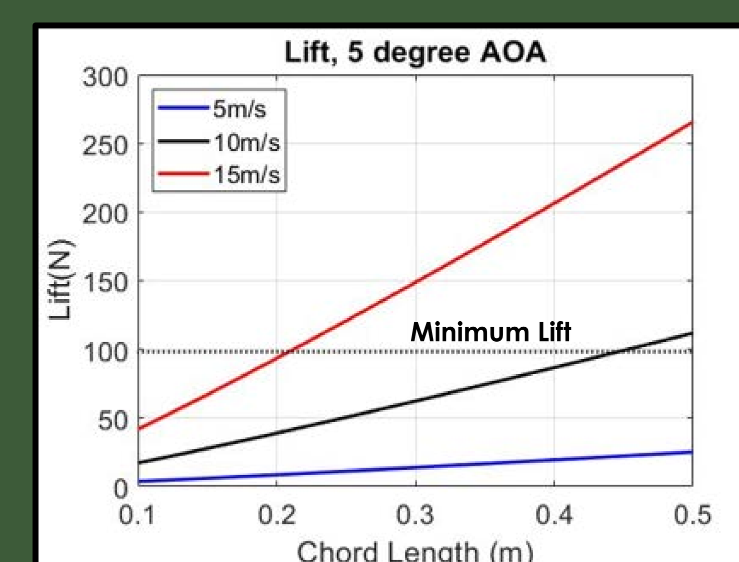
- Skycandy: 4 lbs.
- Biplane: 12 lbs.

The Selig S1223 airfoil is designed for high lift and low Reynolds number applications, perfect for the design requirement of this project.

Selig S1223 airfoil.



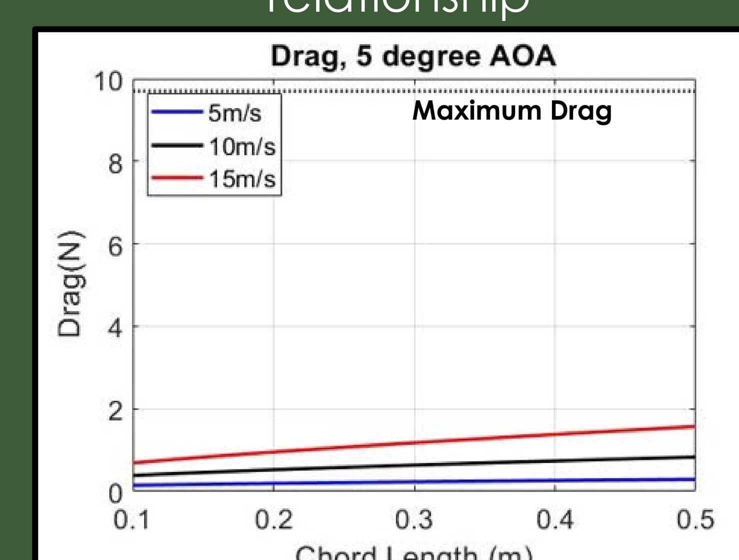
Velocity magnitude plot for S1223 biplane



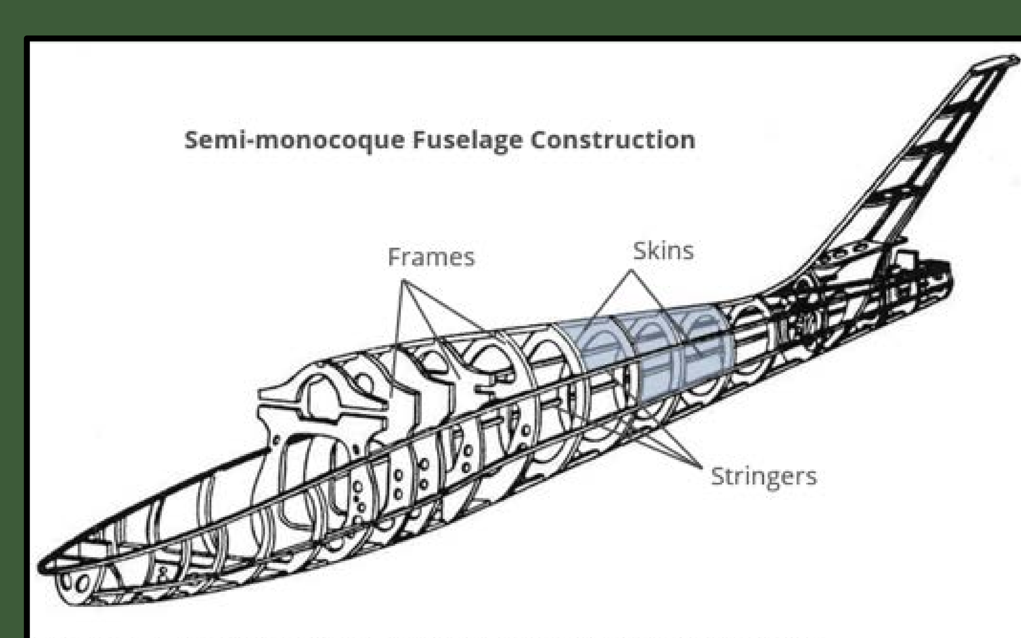
Lift and chord length relationship

Airfoil Analysis:

- As predicted, lift and drag increase with chord length
- A minimum half meter chord is needed for the necessary lift
- Wing drag is far below allowable value

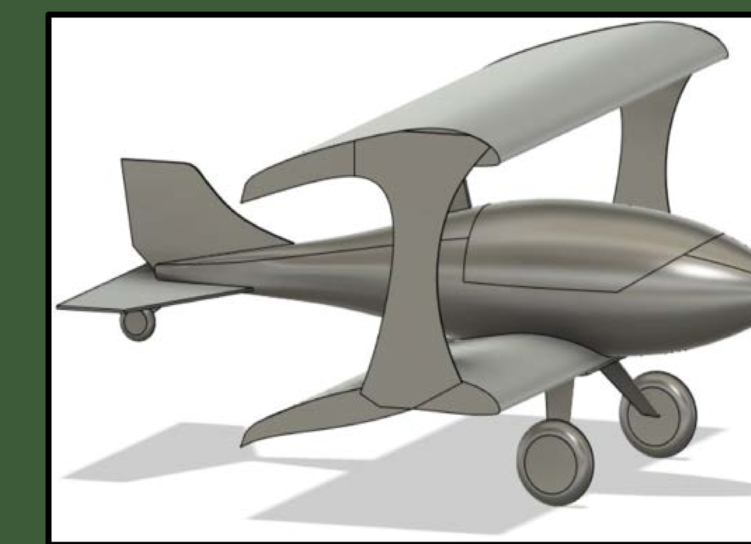


Drag and chord length relationship



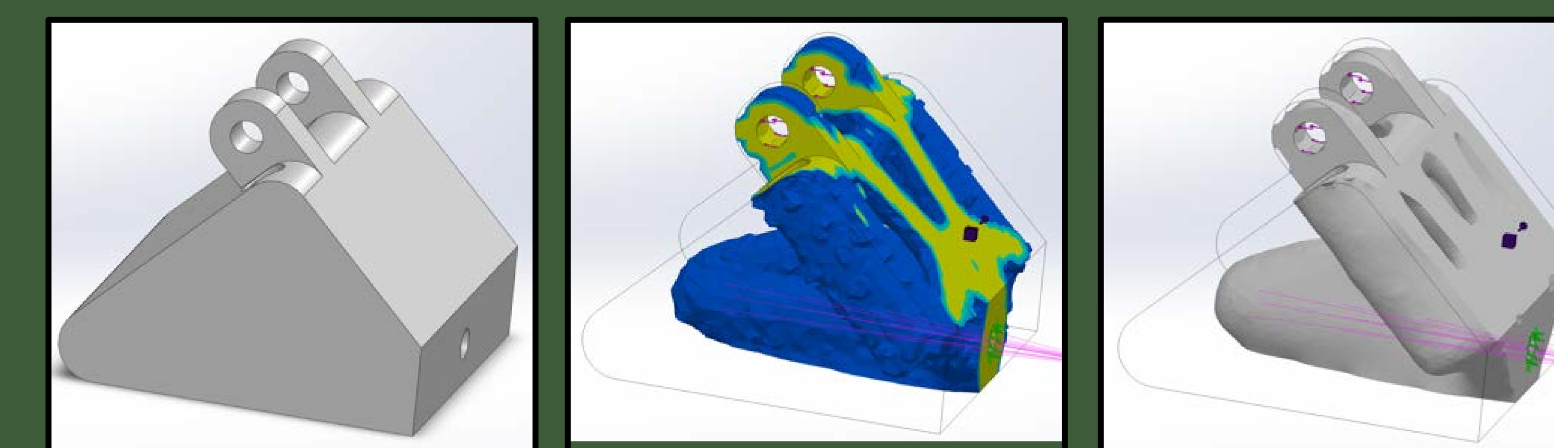
Construction method

The construction method for the final design is a "Semi-monocoque Fuselage Construction".



Stringer/Frame Construction:

- Geometry determined by CAD model
- Number of stringers/frames determined by static analysis



Landing Gear:

- Will experience approximately 2 g's at landing
- Designed with topology Optimization to mitigate failure on landing

Results

Final design of the UAV