

Economical Design of eVTOL Rotor

Project Description:

Current designs for eVTOL rotors are economically challenging to manufacture at scale, especially if this technology is to be expanded towards public transportation and cargo. There is a big push for eVTOL to be a new form of transportation by the late 2020's. The goal for the project is to create an eVTOL blade out of sustainable materials. The blade must meet the provided aerodynamic goals, be structurally sound, and have sufficient flight time. The material must also be affordable due to the high number of rotor blades required for these vehicles. The blade will be created using CAD with the airfoils provided and will then be imported to ANSYS to test the various load conditions.

An example of an eVTOL vehicle from Wisk, a Boeing subsidiary:



Project Requirements:

Aircraft Configuration

Type: Multi-Rotor eVTOL with 4 forward and 4 aft tilting prop rotors on 2 wings.

Weight:

- Empty weight: 8,000 lb
- Maximum gross weight: 9,000 lb
- Disc loading: 16-18 psf (hover)

Performance:

- Design speed: 100 knots (dash up to 120 knots)
- Minimum flight time: 40 minutes per sortie

Blade Configuration

Length of Blades: 48 inches (4 ft)

Twist: 35° linear washout

Market Research:

Company	Company Location	Aircraft Configuration	Passenger or Payload?	Flight Time	# of Rotors	Blades per Rotor	Total Blades
Beta	Vermont, USA	6 Passengers	Passenger/cargo	250 miles	4	5	20
Ehang	Guangzhou, China	Autonomous, 2 passenger	Passenger	22 miles	16	2	32
Joby	Santa Cruz, CA	4 passengers	Passenger	155 miles	6	5	30
Lillium	Germany	6 passengers	passenger	109 miles	30	8	240
Wisk	Mountain View, CA	4 passenger autonomous	Passenger	90 miles	12	4 (rear) or 5 (front)	54
Supernal	Washington DC	4 + pilot	Passenger	60 miles	8	4	32
Volocopter	Beuchsal, Germany	2 person cockpit	Passenger	85 miles	18	2	36
Vertical	Bristol, England	4 person canopy	Passenger	100 miles	4	3	12

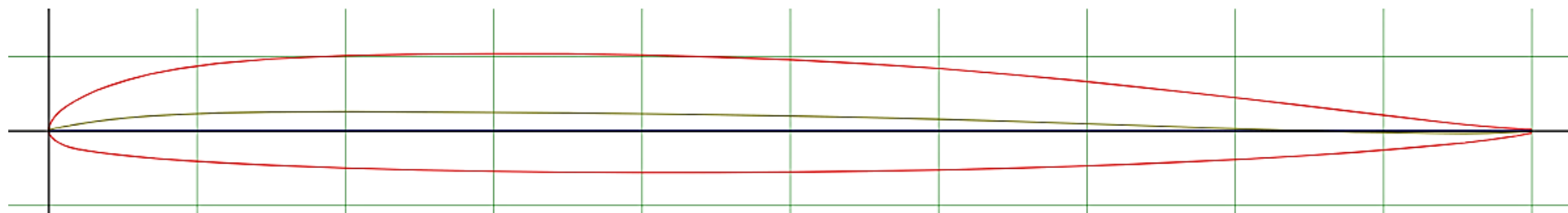
Above shows a table comparing eight of the most influential companies in the eVTOL field. This allowed us to get a better idea on the rotor design that would work best for our requirements. Boeing’s new eVTOL will have four tilling and four stationary rotors, based on this, our team has design freedom on the number of blades per rotor.

Design Options/Possible Solutions:

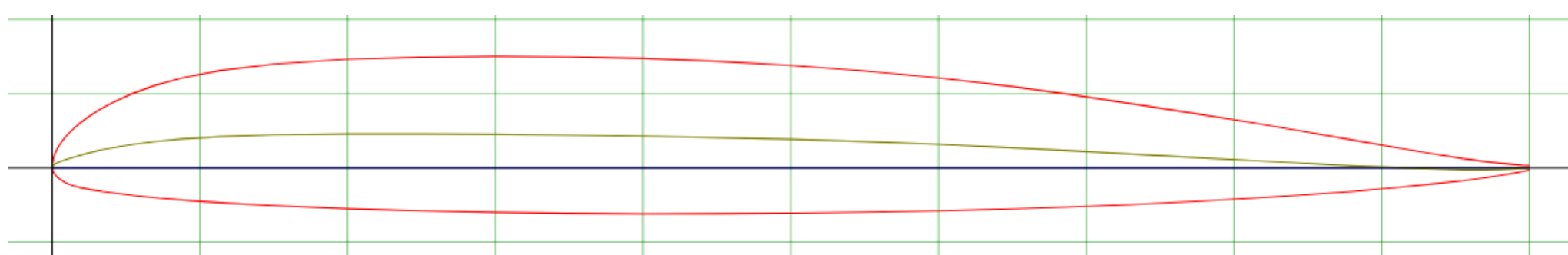
We have decided through our market research that the most appropriate rotor design would be four blades, as this provides 32 total blades on the aircraft which is in the standard industry range.

The cross section of the blade will change as it moves from the center of the rotor to the tip. The root (closest to the center) will be shaped to provide the best structural stability, and moving outward it will be shaped as shown:

Chosen airfoil for the midsection of the blade (40%-80% of the span):



Chosen airfoil shape for the tip of the blade (90%-100% of the span):

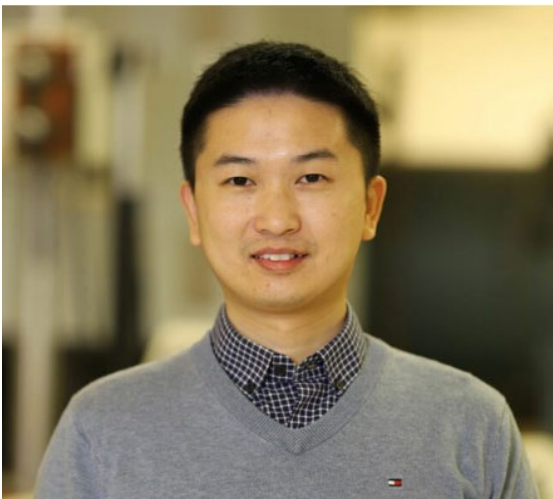


Sources:

1. <https://aamrealityindex.com/aam-reality-index>
2. <https://wisk.aero/aircraft/>
3. <https://evtol.news/vfs-members/>

Semester Deliverables:

1. Market research on eVTOL companies to determine the optimal design.
2. Choosing a viable airfoil and rotor design.
3. Providing a preliminary CAD model of a rotor blade.
4. Initial finite element model (FEM) analysis of the structural mechanics.



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