Blended body-box wing drone development

SDU Eagles

Design & Development

UNLOADED
3.7 KG

STALL LOADED
11.5m/s

1.6kg

ε=1.3*

INERENTEBLY STABLE

1.5m

Modular design

Pixhawk

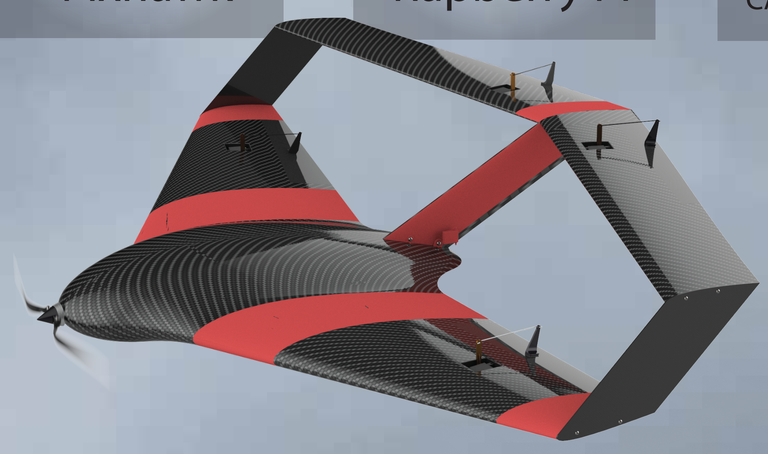
Rapberry PI

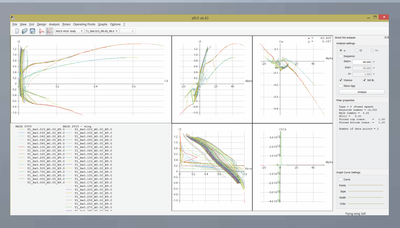
CATAPULT LAUNCH

*Added efficiency up to 30% compared with same sized wing

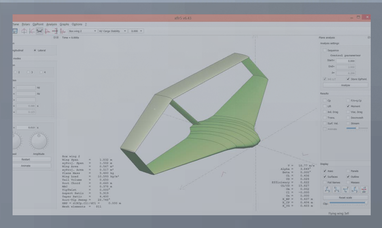
① The team was started by students of the University of Southern Denmark with one goal: **Develop an efficient, modularized and sustainable drone for humanitarian purposes.** With no previous experience in aircraft design or manufacturing, the team embarqued on a jorney of studying, learning by doing, and the commitment to participate in the IMECHE UAS Challenge.

② With the constraints defined above, the development process started. Airfoils were selected to maximize the efficiency for the desired crusing flight conditions. Through an iterative process in XLFR5 and in the parametric model of the aircraft, a good flight behaviour was achieved.





Airfoil Cls, Cds & Cms for alpha



Dutch Roll mode simulation

	Unloaded			Loaded		
	Short Period	Phugoid	Dutch Roll	Short Period	Phugoid	Dutch Roll
Class A	1	2	2	1	2	2
Class B	1	2	1	1	2	1
Class C	1	2	2	1	2	2

Evaluation of the Eagle's aircraft acording to the MIL-F-8785C

Manufacturing & Testing

1st prototype	3D PRINTING	WIND TUNNEL	
1st functional prototype	3D PRINTING	LASER CUTTING	HAND LAY-UP
Final product	CNC MILLING	VACCUM MOLDING	FOAM CASTING

Problem solving through prototyping:

With the elevated center of gravity due to the box wing configuration and due to the difficulties of acomodating a raised motor, the thrust angle had to be pointed downwards. This problem was found during testing, upon notice of a pitching up tendency of the aircraft while throttling up.

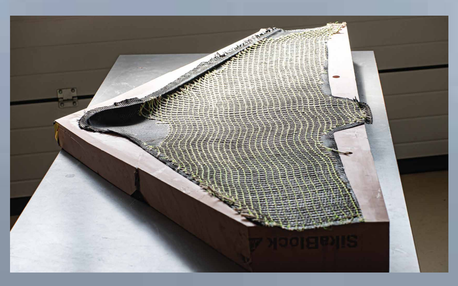
Catapult testing:
The catapult lanches the aircraft with an acceleration of 3Gs. 300 Joules of kinectic energy need to be damped by a spring. After testing and mutiple iterations, a trampoline spring was found to be adequate for dampening the launch car.

③ For the initial prototyping phase, low cost was a priority. **As such, the team used existing equipment available at the university and developed the initial prototypes using desktop 3D printers, a low power laser cutter and hand tools.** With a finished 1:1 scale prototype, it was easier to present the idea and test the behaviour of the drone. A local company offered to manufacture the molds, while access to the university composite lab was provided to the team.

Innovation, Safety & Enviroment

④ Transportation is one of the largest polluters in the world. In the search for a highly efficient solution that would reduce our energy consumption and increase the operating range of our aircraft, we found a long forgotten idea - the Prandtl plane. This box wing configuration minimizes air drag and, as a result, reaches a theoricall efficiency 30% higher than a conventional design.

⑤ The simple yet resilient monocoque body reinforced with natural hemp fibers ensures longevity and low maintenance requirements, while its modularity makes it easy to repair or replace only the affected components, which reduces the waste produced by using our solution. Many of the mechanical and electrical components are standardized and commonly sold around the world, making it even easier to repair the airplane and keep it running.



⑥ A strict safety procedure was developed to prevent injuries while the plane is on the ground.

A designated member of the team dictates when it is safe to approach the plane.

The pilot can terminate the mission if desired via a remote kill switch. The autopile can also terminate the flight if it detects an issue.