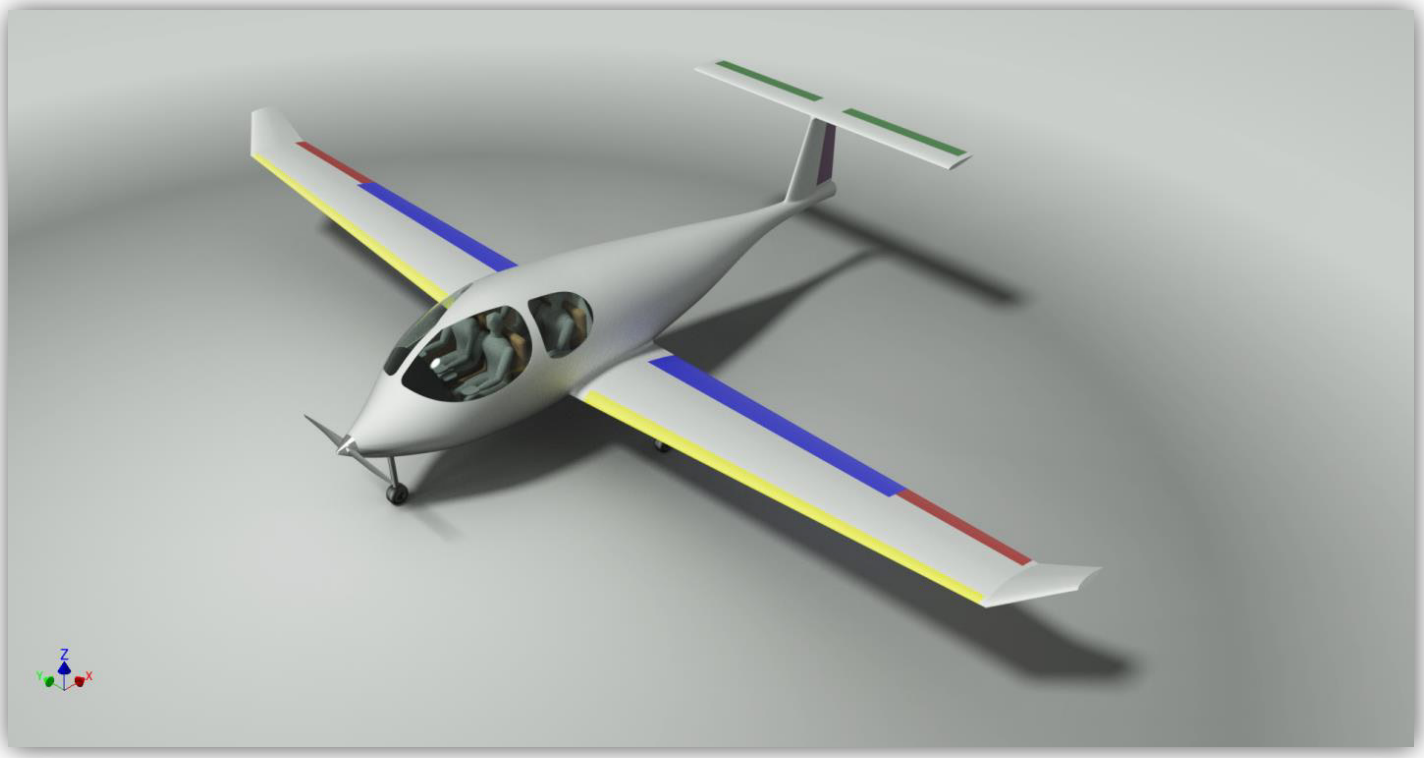
May 18, 2015

THE EG-A BEAMTREE PH-10 AIRCRAFT

RESPONSE TO THE NASA ARMD: E-GA UNIVERSITY DESIGN CHALLENGE
2014-2015



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I. List of Team Members

(from left to right)
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II. Abstract

A Virginia Tech team of 8 undergraduate students are pleased to offer the PH-10, a tractor propeller general aviation all-electric aircraft, in response to the NASA E-GA (Electric – General Aviation) ARMD Design Challenge. The aircraft is designed to be operational by 2020 with no combustion. Overall, the PH-10 has a large wingspan of 48.5 *ft*, with winglets, and a tadpole fuselage 27.9 *ft* long and 10.1 *ft* high. Powered by three lithium-ion battery packs, weighting 2335.5 *lb* total, and propelled by an AC induction motor, the PH-10 is capable of a cruise speed of 175 *knots* for 783 *nmi* with an additional thirty minute reserve and a payload of 800 *lb*. The aircraft can hold up to 4 passengers an exceeds the threshold requirements of a 400 *lb*. payload, a range of 500 *nmi*, a cruise speed of 130 *knots* and a 30 minute reserve at cruise speed.

The heavy weight of the electric propulsion system was the main design driver of the PH-10, leading to the selection of a tadpole fuselage to reduce profile drag and the use of winglets to increase aerodynamic efficiency. Other key design criteria are the infrastructure impact of the energy storage system and the overall cost of both the design and infrastructure components.

Because of the need for electric power within the aircraft, the infrastructure at existing airports and landing strips requires modification. Battery charging can be performed via two methods, either with a 240 *V* outlet or with a supercharging station. The first requires minimal, if any, infrastructure change, while the second carries a cost of $35,000 for purchase and installation. Further investment and research should be performed to investigate the improvement of batteries before 2020 and to address the issue of the environmental control system for electric vehicles draining the power source and decreasing range.

Table 1. Compliance matrix for the PH-10, with both the NASA RFP Threshold and Goal requirements. Compliance is signified with a ✓ for the threshold value and a ☑ for the goal value.

	Threshold	PH-10	Compliance
# Seats	4	4	☑
Range (*nmi*)	500	783	✓
Payload (*lb*)	400	800	☑
Cruise Speed (*knots*)	130	175	☑
Reserve (*min*)	30	30	☑
TO Distance (*ft*)	<3000	1350	☑

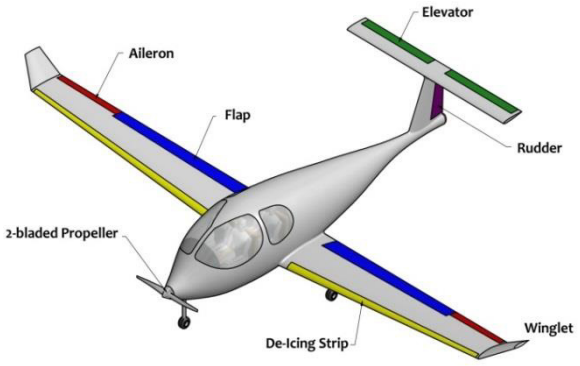

Figure 1. The BeamTree PH-10, featuring a two-bladed tractor propeller, a tadpole fuselage, winglets, and a large wingspan - all to acheive high L/D. The tail includes a large span to counter the large negative moment generated by the NLF airfoil in the wings. The flaps can deflect up to 30 *degrees* to achieve a stall of 61 *knots*.