AIAA DESIGN-BUILD-FLY 2015-2016

Abstract

Each year, the American Institute of Aeronautics and Astronautics (AIAA) releases a Request For Proposals (RFP) for the Design-Build-Fly (DBF) Competition. The competition serves as a real-world opportunity for collegiate students to apply technical and professional skill sets to develop a Small Unmanned Aerial System (SUAS). Studies executed in this program centered around electric propulsion system optimization, design development time, manufacturing time, and methodology to develop a dual-aircraft system of systems. This year was the first that required a dual-aircraft system which introduced scores of new and unique challenges to the design process.

Objectives

1) Maximize the technical documentation score.

2) Minimize the Rated Aircraft Cost (RAC).

3) Complete all of the flight missions with a maximum score.

4) Study material selection processes for SUASs.

5) Study manufacturing processes for SUASs.

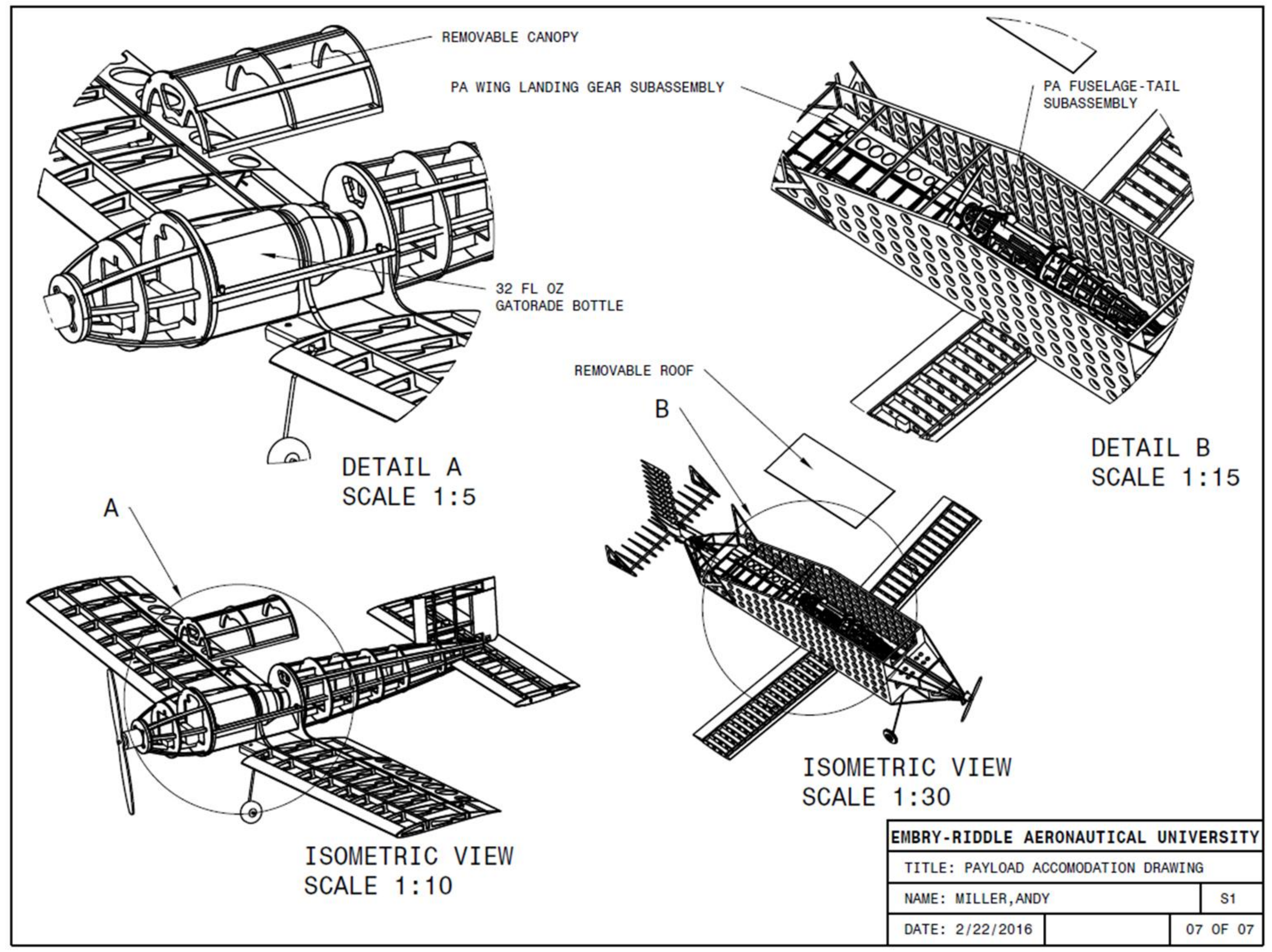
6) Study electric propulsion subsystem optimization for SUASs.

7) Study low Reynolds number aerodynamics for application to a SUAS.

8) Execute a managerial study to quantify SUAS development cost in terms of man-hours.

9) Create an educational environment to cultivate informational convection among new and returning teammates.

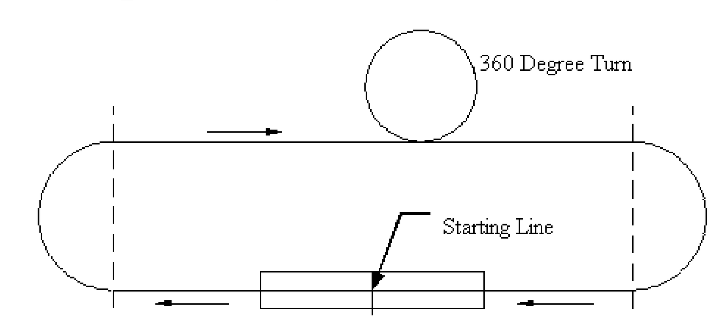
Final Product Designs



Flight Mission & Scoring Description

The flight missions defined the aircraft requirements. A Production Aircraft (PA) and Manufacturing Support Aircraft (MSA) were developed to satisfy the requirements derived from the mission profile. The second flight mission involves the MSA transporting the PA as its payload. The number of subassemblies, N, that the PA is broken into for that mission is a divisor in the total score, as well as the battery and structural weights (B and S, respectively) of both aircraft. The subscripts of 1 and 2 refer to the PA and MSA, respectively.

$$\textit{Total Score} = \frac{\textit{Report Score} * \{M_1 * M_2 * M_3 + M_{Bonus}\}}{\{N[B_1S_1 + B_1^{\,2}]\} + \{B_2S_2 + B_2^{\,2}\}}$$



Mission	Potential Scoring Outcome	Use Case Description
1) Manufacturing Support Arrival Flight	2	MSA (no payload) completes 3 laps within 5 minutes and completes a successful landing.
	0.1	MSA does not attempt or complete a successful flight.
2) Manufacturing Support Delivery Flight	4	MSA transports all PA sub-assemblies one course laps within 10 minutes and completes a successful landing
	1	MSA transports less than all of the PA sub-assemblies within 10 minutes and completes a successful landing.
	0.1	MSA does not attempt or complete a successful flight.
3) Production Aircraft Flight	2	PA completes 3 laps within 5 minutes with 32 fl. oz. Gatorade bottle as payload with a successful landing.
	1	PA completes less than 3 laps in 5 minutes with 32 oz. Gatorade bottle as payload with a successful landing.
	0.1	PA does not attempt or complete a successful flight.
4) Bonus Ground Mission	2	PA is converted from sub-assemblies to complete assembly and passes wing tip lift test in under 2 minutes.
	0	Any other result.

Key Findings

1) 1750 man-hours are required to develop a mission-specific SUAS from conceptual design through flight testing. 3500 man-hours were invested in this program.

2) 3D Printing, CNC Manufacturing, and laser cutting are key technologies that improve product quality of SUASs in comparison with manual production.

3) Current draw below 63% of a NiMH battery's C-rating will lead to significantly improved endurance compared to higher current draws.

4) Softwoods and fiber composite materials have specific structural applications to minimize the weight of SUASs.

Product Flight Testing

Above: Manufacturing Support Aircraft in-flight photo.

Above: Production Aircraft in-flight photo.

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