GRYPHON: A BWB Aircraft Utilizing TeDP for Next-Generation Commercial Transport

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Organization: Columbia Space Initiative (CSI), Columbia University, New York, NY 10027 **Submitted**: June 12, 2017

ABSTRACT

Despite efforts to minimize the environmental impact of aviation using existing technologies, the continued growth of the aviation industry by a projected 2.9 percent in GDP [1] makes the development of greener aeronautical technologies a top priority. Massive quantities of Nitrous Oxide (NOx) and Carbon Monoxide (CO) emissions are released into the atmosphere annually by current tube and wing aircraft. In response to the environmental effects of aeronautical transport, NASA has set goals for reducing emissions, fuel burn, and noise for future generations of aircraft up to the 2035+ time frame (N+3). To achieve such lofty goals, new, innovative technologies must be integrated into the planes of the future, particularly transport class jets. Blended Wing Body aircraft and Turboelectric Distributed Propulsion are two such technologies that require a fundamental shift in how we think about, design and manufacture planes. However, the implications of such a transition are significant. Furthermore, utilizing materials that are lighter, more temperature resistant and stronger, improving the aerodynamics, and implementing cutting edge combustors are among many additional steps that can be taken to usher in a new generation of quieter, more fuel efficient and more environmentally friendly aircrafts.

The GRYPHON is our response to the NASA Langley Advanced Air Vehicles Student Competition which calls for a student designed aircraft to meet NASAs N+2 goals These include a 32-42 dB reduction in noise, 80% reduction in NOx emissions, and a 50-60% reduction in fuel consumption. The GRYPHON is so named after the mythical creature that is half-eagle and half-lion (Columbias mascot). It is designed to meet these goals while taking into account feasibility in the stated mid-term timeframe, the safety of the aircraft, cost efficiency, and a variety of other factors.

The GRYPHONs remarkable efficiency is made possible by technological innovations in almost all of its flight systems, while remaining technologically feasible in the projected development window. It sports a blended wing body, chosen for its aerodynamics efficiency, large capacity, and potential for propulsion-airframe integration. The wings are modeled after the PRANDTL-D bell-shaped span-loaded wings which minimize induced drag and promote proverse yaw when maneuvering. The propulsion system utilizes Turboelectric Distributed Propulsion, a novel propulsion configuration that significantly increases the Bypass Ratio (BPR) and utilizes Boundary Layer Ingestion (BLI) to reduce drag. This is used in conjunction with engines that use the novel axially controlled stoichiometry (ACS) concept combustor design, superconducting generators and lightweight Ceramic Matrix Composites (CMCs). Finally, we also have taken advantage of novel materials, composites, and structures in our airframe which makes use of Boeings PRSEUS concept in the y-braced box frame fuselage. We also use a variety of other composites like CFRP and more traditional aluminums in the wing and fuselage skins.

This paper details the design of the GRYPHON, reviewing the methodology, justifications for design choices, and market analysis along the way. While the immediate scope of our submission may be limited to this NASA challenge, we hope that, in the future, this work may be used to accelerate the transition to the next generation of greener aviation.

Key words. blended-wing aircraft – PRANDTL wing – high-efficiency propulsion