Partior Q-1

NASA University Contest: DEP Design Challenge 2015
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Abstract:

NASA's University Contest for the academic year of 2015-2016 focused on the application of Distributed Electric Propulsion (DEP) to a 19-Passenger Commuter aircraft. DEP is an emerging technology that has been successfully applied to small aircraft in tests done by and currently being done by NASA. The Request for Proposal (RFP) as a bottom line desired a design which implemented DEP on a much larger aircraft than any that NASA has tested so far. This craft was to look to technology a decade down the road and apply it to a design that would be competitive in a future market.

In order to be competitive, there was a huge emphasis on fuel economy and cost of the new air craft. Additionally, it still needed to meet the requirements of a typical 19-passsenger commuter to remain competitive in the market. For this requirement, the plane needed to travel 250 mph for 800 nmi, have a service ceiling of 28,000 ft and take off in less than 3000 ft. While the cruise requirement is about 60 mph less than comparator aircraft, the DEP air craft was expected to compensate with 1000 ft shorter takeoff and landing capabilities.

The Partior team began the process of design by creating 3 initial concept planes with varying attributes relating to the propulsion type, fuselage shape, wing geometry, etc. From those initial concepts the team was able to run trade studies on individual components as well as system integration in order to narrow down the design of each piece of the puzzle.

Ultimately, the result was the Partior Q-1. Its primary feature is the DEP technology prominent on the leading edge of the wings. The Q-1 operates in two main regimes of flight: takeoff and landing. For each regime it uses a different configuration of its propellers. For the cruise regime, it operates only two fixed blade cruise propellers. These props have been optimized for cruise and this perform best around 250 mph and 25,000 ft. The takeoff regime adds 6 takeoff propellers to the 2 cruise propellers in order to create a high lift DEP effect across the entire leading edge of the wing. These six props are also optimized for 100 mph at sea level and provide an exorbitant amount of thrust. The high thrust compounded with the high lift effects of DEP enable an extremely short takeoff of only 3000 ft.

DEP also allowed for a very high wing loading while still maintaining that takeoff distance. The high wing loading lead to extreme savings in fuel economy. The Q-1 is expected to increase fuel economy up to 47% over comparator aircraft, achieving 133 miles/gal/passenger to the comparator's 90. By replacing the traditional turboprop engines with APUs from a 787 and 8 electrical motors, the Q-1 was also able to reduce weight as well as manufacturing costs coming in at about $6.1 million against comparator's $6.7 million.

NASAs request ultimately proved successful from a conceptual standpoint. The Partior Q-1 demonstrates that the technology is available or soon to be available to create such a craft. The technology was largely enabled by progress in the electric motor field made recently by Siemens. If Siemens or other companies can scale the technology that they have already create to larger scales, the possibilities are endless for the scalability of DEP aircraft from the Partior Q-1 and bigger.