15 - Manned Martian Aircraft

As interest in the exploration and settling of Mars grows, so does the need for efficient and rapid transport of the Red Planet's new inhabitants. With plans to launch a crewed mission within the ideal launch window of 2033, the agencies responsible for these missions must soon develop a vehicle capable of transporting their crews. The main challenges are the thin atmosphere of Mars (more than 60 times thinner than Earth), the dusty and rugged environment, and a lack of infrastructure, including for fuel generation.

Mission Objective

The objective of the manned Martian aircraft is the rapid transportation of two astronauts over distances of at least 1000 km. The astronauts will be carrying scientific instruments and collected samples, which must be stowed in the vehicle. If successful, the aircraft will alleviate limitations on landing sites for crewed missions to Mars, enabling exploration of scientifically important areas that are not accessible otherwise. Long-term, such a system can connect a network of bases spread over the planet and enable a sustainable human presence on Mars.

System Design

The main constraints of the project, relating to the aircraft's operational capabilities and the available design space, allowed for the investigation of both conventional and unconventional designs. The top-level requirements of a 1000 km range, 400 km/h cruise speed, capacity for 2 astronauts, and an additional 100 kg payload led to the parallel development of 5 designs. These included an Airship, Flying Wing, Biplane, Tilt-rotor and Multicopter. From these 5 options, a trade-off determined that an electric tilt-rotor concept would perform best with the criteria selected.

The tilt-rotor can take-off and land vertically thanks to two sets of counter-rotating blades at the wing tips. These blades provide the necessary thrust to function as a helicopter when performing take-off and landing maneuvers and provide the aircraft the capability to hover. For long-distance flight, the rotors align with the wing and provide the required thrust to cruise at a speed of 400 km/h, while the wing, with a span of 44.75 m (similar to that of a Boeing 767) provides the lift required. The use of electric batteries allows the aircraft to perform in the thin, oxygen-deprived atmosphere of Mars, and installing solar panels on the wing's upper surface allows the system to recharge itself in remote areas without requiring any infrastructure. Next, the presence of life-support systems aims to complement that already present in the crew's suits, providing water and oxygen for long-distance flights. Overall, using carbon fiber composites ensures a lightweight structure and a long lifetime in the radiation-intensive environment of Mars.

Looking ahead, the final weeks of the Design Synthesis Exercise will be used to compile all findings into a concise report, finalize all system renderings, and prepare for the upcoming presentations of the Final Review and the Symposium.