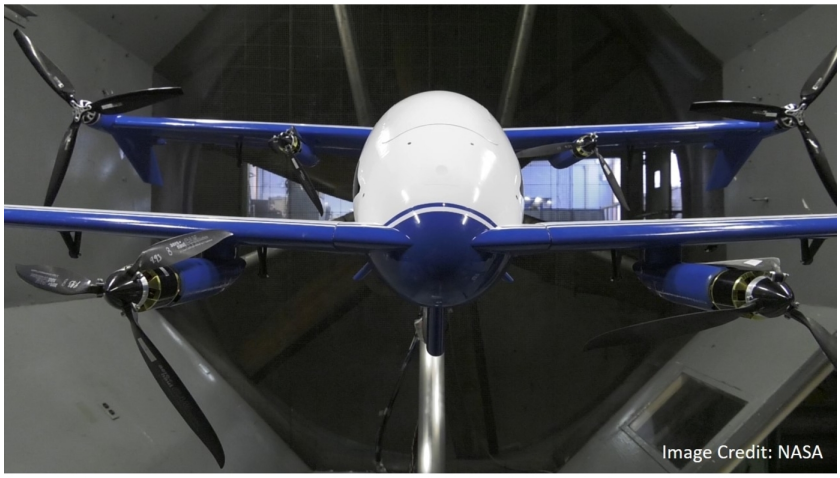
National Aeronautics and
Space Administration



TECHNOLOGY SOLUTION

Aerospace

Fixed Wing Angle eVTOL

VTOL Without Performance Limitations

Current electric vertical takeoff and landing aircraft (eVTOL) configurations for Urban Air Mobility (UAM) applications often require performance-hindering equipment only used for a specific operation (e.g., takeoff or cruising). The need for such equipment, such as separate lift and thrust mechanisms, often stems from the challenge posed by transitioning from hovering to forward flight. For example, tilt-wing eVTOLs have complex transition periods that can result in large pitching movements or wing stalling without adequate propulsion, potentially causing catastrophic loss of control. Increased equipment requirements for eVTOLs also increase system mass, negatively impacting performance.

Innovators at NASA's Langley Research Center recognized this issue and have developed a novel eVTOL solution design. The technology is a distributed electric propulsion, modular wing aircraft capable of vertical takeoff and landing, without requiring near 90° wing tilt. Instead, NASA's eVTOL uses large flaps and a fixed slight wing tilt to generate upward force, enabling VTOL operations, benign transition from hovering to forward flight, and increased safety and simplicity of operations.

BENEFITS

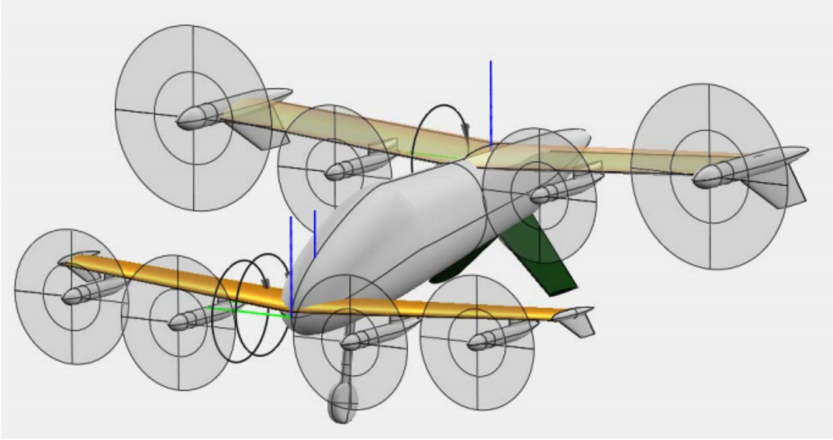
- Eliminated performance-hindering equipment: Removing the need for active wing angle actuation reduces hardware requirements, resulting in decreased mass and increased performance
- Smooth transition operations: Enables benign transition from hovering to forward flight (only requires a small attitude change) - ideal for air taxi applications
- Increased operational simplicity: Eliminates the need for mechanisms to manipulate wing angles during transitions from takeoff to forward flight

THE TECHNOLOGY

While previous eVTOLs often require a near 90° wing tilt to position propellers in an optimal location to generate vertical force for takeoff, NASA has taken a very different approach. NASA's design instead uses a slight wing angle and large flaps designed to deflect slipstream generated by the propellers to create a net positive force in the vertical direction, all while preventing forward movement. This unique configuration allows for takeoff and landing operations without the need for near 90° wing tilt angles. After takeoff, the transition to forward flight only requires a slight change in attitude of the vehicle and retraction of the flaps. Similar solutions require large changes in attitude to accomplish this transition which is often undesirable, especially for air taxi operations that involve passengers.

Given the effectiveness of this configuration for generating upward force, the requirement for wing angle tilt has been reduced from near 90° to approximately 15° during takeoff. Further iterations may reduce this requirement even further to 0°. By eliminating the need for near 90° wing tilt, NASA's eVTOL design removes the need for mechanisms to perform active tilting of the wings or rotors, reducing system mass and thereby improving performance. Flaps represent the only components that require actuation for takeoff and landing operations.

Innovators at NASA leveraged the Langley Aerodrome 8 (LA-8), a modular testbed vehicle that allows for rapid prototyping and testing of eVTOLs with various configurations, to design and test this novel concept.



NASA's LA-8 UAM testbed vehicle used to design and test this unique configuration. Image Credit: NASA

APPLICATIONS

The technology has several potential applications:

- Urban air mobility: eVTOL passenger vehicles for air taxi services
- Drone delivery: eVTOL delivery vehicles
- Industrial applications: eVTOL vehicles are being considered for use in various industries including agriculture and construction

PUBLICATIONS

Patent No: 9,475,579; 9,896,200

Patent Pending

"An Experimental Approach to a Rapid Propulsion and Aeronautics Concept Testbed," McSwain, Robert et. al., January 1, 2020, https://ntrs.nasa.gov/citations/20200000698

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NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

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More Information

National Aeronautics and Space Administration

Agency Licensing Concierge

Langley Research Center

Mail Stop 020
Hampton, VA 23681
202-358-7432
Agency-Patent-Licensing@mail.nasa.gov

www.nasa.gov

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