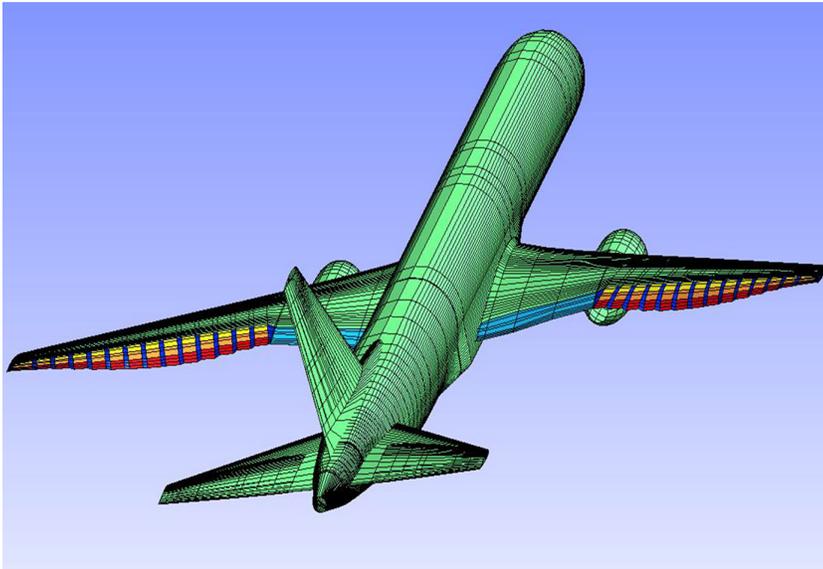




## TECHNOLOGY SOLUTION

### Aerospace



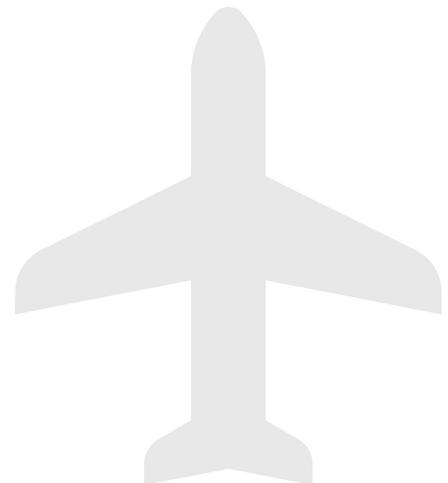
# Aeroelastic Wing Shaping

## Method for Aeroelastic Wing Shaping Using Distributed Propulsion

NASA has developed a new method of wing shaping using distributed propulsion that can revolutionize the design of aircraft. Distributed propulsion aeroelastic wing shaping is a new aircraft concept. Most commercial aircraft are still utilizing one gas-turbine engine per wing. By contrast, distributed propulsion envisions the use of multiple small electrically powered propulsion units distributed along the wings. By taking advantage of increased wing flexibility afforded by the use of light-weight materials such as composites, the aeroelastic deflection of a wing can be actively shaped in-flight for optimal aerodynamic efficiency by varying the amount of thrust generated by the propulsion units. By using distributed propulsion, the optimal wing shape can be used for other phases such as takeoff, landing, and in-flight maneuvers. In addition, distributed propulsion can be leveraged for yaw and roll controls, thus reducing the need for a full vertical tail size for weight savings. Thus, an entire aircraft design can be developed more creatively using distributed propulsion concepts for reduced fuel burn. Initial performance analysis indicates that this concept could achieve about 4% increase in lift-to-drag ratio.

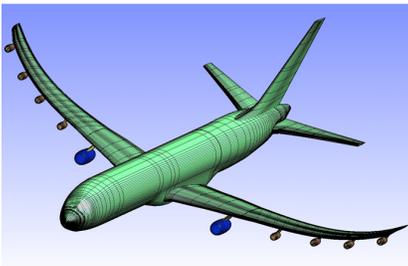
### BENEFITS

- Increase in lift-to-drag ratio
- Decrease fuel costs
- Increase range and endurance
- Reduce vertical tail size
- Maintain aeroelastic stability
- Decrease environmental impact

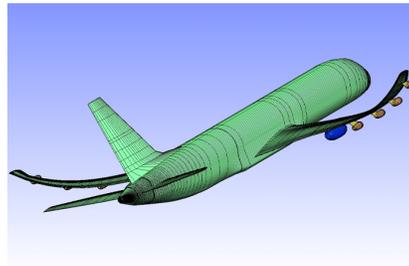


## THE TECHNOLOGY

Distributed propulsion and lightweight flexible structures on air vehicles pose a significant opportunity to improve mission performance while meeting next generation requirements including reduced fuel burn, lower emissions, and enhanced takeoff and landing performance. Flexible wing-shaping aircraft using distributed propulsion enable the ability to achieve improved aerodynamic efficiency while maintaining aeroelastic stability. Wing shaping concepts using distributed propulsion leverage the ability to introduce forces/ moments into the wing structure to affect the wing aerodynamics. This can be performed throughout the flight envelope to alter wing twist, hence local angle of attack, as the wing loading changes with air vehicle weight during cruise. Thrust-induced lift can be achieved by distributed propulsion for enhanced lift during take-off and landing. For a highly flexible wing structure, this concept could achieve a 4% improvement in lift-to-drag ratio, hence reduced fuel burn, as compared to a conventional stiff wing. This benefit is attributed to a reduction in lift-induced drag throughout the flight envelope by actively shaping the spanwise lift distribution using distributed propulsion. Vertical tail size could be reduced by utilizing differential thrust flight-propulsion control. This will result in weight reduction to achieve further fuel savings. Aeroelastic stability is addressed in the design process to meet flutter clearance requirements by proper placement of the propulsion units. This technology enables synergistic interactions between lightweight materials, propulsion, flight control, and active aeroelastic wing shaping control for reducing the environmental impact of future air vehicles.



Wing shaping using distributed propulsion



Transport aircraft

## APPLICATIONS

The technology has several potential applications:

- Commercial and military transports
- Unmanned Aerial Vehicles
- General Aviation
- Rotorcraft
- High altitude long endurance vehicles

## PUBLICATIONS

Patent No: 9,751,614

[technology.nasa.gov](http://technology.nasa.gov)

**More Information**

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