
U.S. Air Force photo

National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Aerospace

Pinpointing Consumption "Sweet Spot" Makes Formation Flight More Fuel Efficient

A new method of estimating the optimal trailing aircraft position in a formation increases fuel savings.

NASA researchers have conceptualized a way to more accurately estimate the best location for a trailing aircraft in a formation in order to optimize fuel efficiency. The wake vortex of a leading aircraft creates an updraft that minimizes drag on a trailing aircraft, resulting in reduced fuel consumption. This method estimates the location for optimal fuel savings. Operators can save 5 percent to 10 percent in fuel costs per hour through optimal aircraft placement. Given that a loaded aircraft uses thousands of gallons of fuel per hour, even minor improvements in fuel efficiency can add up to significant savings.

BENEFITS

- Accurate: Increases the accuracy in assessing optimal aircraft placement during formation flight
- Economical: Formation flight reduces fuel consumption and cost
- Environmentally friendlier: Lower fuel consumption translates to lower emissions

THE TECHNOLOGY

Formation flying—when one aircraft flies behind another—reduces drag and results in improved fuel consumption in the trailing vehicle. However, no sensor currently exists that directly measures drag. Instead, pilots rely on fuel flow measurements or induced aircraft moments—roll, pitch, and yaw—to estimate the best location within a leading vehicle's wave vortex. Fuel flow alone is a lagging drag estimate, which leads to inaccurate estimates. Aircraft moments alone also do not sufficiently indicate the best location for the trailing aircraft. This patented software technology offers a solution.

How It Works

NASA's drag performance function software combines fuel flow measurements ("slow" but direct measures of performance) and aircraft moments ("fast" but indirect measures of performance) to guide an aircraft in formation flight to a relative position that reduces drag. The technique uses a predetermined assortment of weighted measurements and feeds them into a peak-seeking control system. As new fuel flow measurements are available, the control system updates the optimal weightings.

Why It Is Better

The system uses readily available aircraft measures to quickly and more accurately estimate the optimal location for drag reduction. Even relatively small reductions in drag can add up to significant fuel conservation and cost savings.

APPLICATIONS

The technology has several potential applications:

- Commercial air cargo
- Military transport

PUBLICATIONS

Patent No: 9,864,380

"Methods of Constructing a Blended Performance Function Suitable for Formation Flight," American Institute of Aeronautics and Astronautics, https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20170000459.pdf

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DRC-012-028, DRC-TOPS-22

More Information

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NP-2019-04-2677-HQ