



# Transportation Spinoffs



Charged with carrying the human race to frontiers distant and challenging, it only makes sense that NASA has had a profound impact on transportation. Since its founding in 1958, NASA's pioneering research has advanced aeronautics and other modes of transportation as well. Through partnerships with private industry, NASA expertise and technologies developed for space travel are leading to safer, more efficient, and more environmentally friendly transportation on Earth. Whether providing for zero-emission automobiles, warning airplane passengers of turbulence, or saving millions of gallons of fuel, these spinoffs—among the over 1,600 such technologies NASA has recorded—are taking us places



## Insulating Foams Save Money, Increase Safety

Polyimide foam insulation developed by NASA for cryogenic propellant tanks on the space shuttle has been improved through partnership with private industry. The flame retardant, flexible foam—a “NASA Commercial Invention of the Year”—shows promise for use in watercraft, aircraft, and automobiles.



## Polyimide Resins Resist Extreme Temperatures

Designed as an environmentally-friendly alternative to other resins capable of combating the high temperatures of aerospace applications, RP-46 is now used for thermal skins on aircraft, aerospace engines, and exhaust duct systems. Other applications include the high-speed motor sports industry.



## Lithium Battery Power Delivers Electric Vehicles to Market

NASA contributed engineering experience to the development of an advanced battery management system for electric cars and tested a fleet of the zero-emission vehicles, leading to a series of commercially available, purpose-built, lithium electric autos aimed at the urban and commuter environments.



## Aerodynamics Research Revolutionizes Truck Design

Starting in the 1970s, NASA conducted tests to refine the shape of trucks to reduce aerodynamic drag and improved efficiency. This core research led to a change in the design of the modern semi truck, a softening of the leading edge that greatly improves fuel efficiency.



## Turbulence Detection Steers Aircraft Clear of Choppy Air

NASA designed software for aircraft radar that can provide flight crews advance warning of turbulence, helping keep themselves and their passengers out of harm's way, or, at a minimum, allowing the crew to prepare the aircraft for a bumpy ride.



## Comprehensive Software Eases Aircraft Traffic Management

To help air traffic control centers improve the safety and the efficiency of the National Airspace System, NASA developed the Future Air Traffic Management Concepts Evaluation Tool (FACET), which alerts dispatchers to forecasted demand and capacity imbalances, helping them anticipate and act to relieve congested airspace and delays at airports.



## Fluid Prevents Ice Before It Forms

An environmentally friendly anti-icing fluid, invented by NASA, keeps hazardous ice from building up on airplane wings, improving safety while saving time and money. The fluid is also available as a spray for automobile windshields, providing protection down to 20 °F.



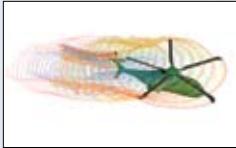
## Guidance System Provides Pilots with Synthetic Vision

NASA and research partners created a 3-D display for pilots which provides clear vision regardless of outside conditions. The system—now flying in small aircraft all over the world—creates a computer-generated view of the surroundings, as well as flight plans and feedback about the area outside of the aircraft.



## Winglets Improve Fuel Efficiency

The winglet is an upturned wingtip, a lifting surface designed to operate in the wingtip “vortex,” a whirlpool of air at an airplane’s wingtips. It takes advantage of the turbulent vortex flow by producing forward thrust. This reduces drag and improves fuel efficiency.



## Modeling Tool Advances Rotorcraft Design

NASA-funded research developed a comprehensive tool for the three-dimensional modeling of the complete aerodynamics of rotorcraft in general flight conditions. The software performs analysis on advanced aerodynamic designs and aids research on new designs. It is currently used by major rotorcraft manufacturers and the U.S. military.

For more information about NASA spinoffs, please visit [spinoff.nasa.gov](http://spinoff.nasa.gov).