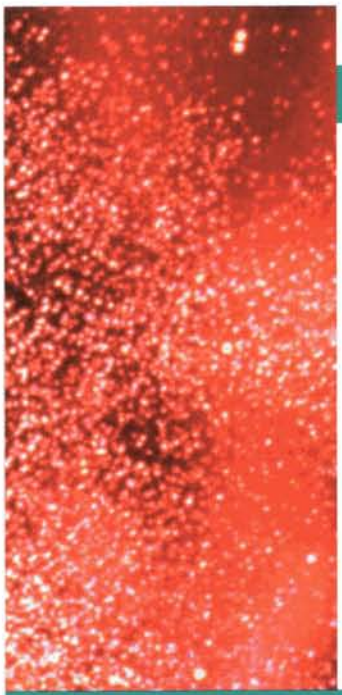

Transportation

Winglets for the Airlines

Performance-improving airfoils for jetliners head technology transfers in the field of transportation

One important way in which government technology is transferred to the civil economy is NASA's aeronautical research program. The agency seeks to develop advanced technology for coming generations of aircraft and at the same time provide new technology to resolve aviation's most pressing current problems. This effort exemplifies the direct benefit transfer, involving development of technology to meet a specific need, as opposed to the indirect benefit that accrues from spin-off, the secondary application of technology developed originally for the needs of NASA's mainline programs.

For more than three quarters of a century, NASA and its predecessor agency have contributed a truly impressive array of innovations over a very broad spectrum of aviation needs. This work has significantly benefited the U.S. economy by elevating the competitive posture of America's plane builders in the international market place; it has benefited those who fly by contributing to flight safety and airplane performance; and it has benefited the general public by improving the environmental characteristics of flight systems.

An example of NASA's aeronautical research is the winglet, a sort of upturned wingtip that is seen more and more frequently at airports. Originally developed by Langley Research Center, the winglet has been in service for more than 15 years aboard business jets and other aircraft, and now it is in regular airline service as a fuel-saving aid to such long-ranging aircraft as the MD-11 jetliner, built by McDonnell Douglas Corporation's Douglas Aircraft Company, Long Beach, California.

Winglets are in airline passenger service on the McDonnell Douglas MD-11 trijet, pictured here in Delta Air Lines livery.

A vertical extension of the aircraft wing, the winglet is a lifting surface designed to operate in the wingtip "vortex," a whirlpool of air that occurs at an airplane's wingtips. The vortex is a complex, turbulent flow that creates drag; the winglet's job is to take advantage of the turbulent vortex flow by producing a degree of forward thrust, in a manner much like a boat's sail. This extra thrust reduces drag and provides a substantial improvement in fuel efficiency, which can be translated into greater payload or longer range for a given fuel load.

Langley's winglet work was part of the Aircraft Energy Efficiency program, NASA's contribution to the national energy conservation effort during the oil crisis years of the 1970s. Langley successfully demonstrated the basic winglet technology in wind tunnel and flight tests, but since the wingtip vortex effect differs with each aircraft, final design and validation remained a question for aircraft manufacturers. To promote the widest possible use of winglets, NASA awarded contracts to aircraft manufacturers for studies of what the winglet

Shown undergoing test aboard a NASA research aircraft, winglets (the vertical extensions of the wingtips) act like boat sails to produce extra thrust and lengthen an airplane's range.

could do for certain existing commercial aircraft and for airplane designs still on the drawing board.

Douglas Aircraft conducted three such studies for NASA in 1978-79, one of them involving wind tunnel tests of winglets on the company's DC-10 transport, another on the application of a complete wing/winglet system to a hypothetical advanced commercial airliner. Both studies showed that significant performance gains, in particular reduced fuel consumption, could be realized by use of winglets.

NASA and Douglas teamed on a 1982 flight test program of a DC-10 trijet fitted with winglets and once again found that the airfoils offered a measurable improvement in fuel consumption. That was an important consideration for Douglas Aircraft at that time, because on the company's drawing board was a larger, high capacity, advanced technology derivative of the DC-10; ultimately to become the MD-11, the big trijet was intended for the extra-long routes across the Pacific Ocean and it was to be one of the longest-ranging planes ever flown.

The MD-11 development program began in 1986. From the beginning, its designers incorporated winglets as an important part of the configuration to help attain the required combination of large payload (290-plus passengers) and very long range (more than 8,200 miles). The MD-11 made its first flight in January 1990 and the 10-month certification flight test program that followed verified the expected aerodynamic benefits of the winglets. The trijet transport went into airline service early in 1991 and there are now more than 100 MD-11s plying the world's airways.