

# What's with winglets?



Today few industry stakeholders would contest the advantages of winglets; in addition to the significant fuel-savings they offer, these wingtip extensions give airlines the options to fly heavier, higher, faster and further with less emissions. By 2010, Aviation Partners Boeing (APB) expects blended winglets to have saved the world's airlines over 2 billion gallons of fuel. *Aircraft Technology* reports.

The figures speak for themselves — counting the Gulfstream GII and the Raytheon Hawker 800, blended winglets are installed on over 1,800 aircraft worldwide. Southwest Airlines, the US low-cost carrier famous for staying in the black, has added blended winglets to its existing fleet of 737-700s and new 737-700s arrive from the manufacturer with them already installed. Additionally, Southwest began installation on the 737-300 aircraft earlier this year. Aviation Partners Boeing (APB) is currently selling 2.1 sets per calendar day and in 2007 it plans to install winglets on 785 aircraft.

Blended winglet technology made its market debut as a performance enhancement programme for the Gulfstream GII. In the mid-90s, The Boeing Company adopted blended winglet technology for the Boeing Business Jet and 737NG. Seattle-based APB was formed in 1999, a joint venture between Aviation Partners Incorporated (API) and Boeing. API owns 55 per cent of the company and Boeing owns 45 per

cent. APB has rights to the winglet in the retrofit market and Boeing has the right to use blended winglet technology on new aircraft.

According to APB, blended winglets can reduce fuel costs by as much as five per cent. Airlines clearly believe in this product, as nearly every US major has signed up. Fuel savings are of course paramount, but the increased wing efficiency also allows for: increased range, greater payload and improved take-off performance. "When winglets were developed for the Gulfstream II it was all about improving the range capability so that it could do a trans-continental flight without a fuel stop...But as fuel prices have quadrupled over the last few years, savings have become much more important in terms of why airlines are interested in the technology," explains Patrick LaMoria, APB VP sales and contracts.

Winglets are commonly installed on 737NGs (at the 737NG factory three-quarters of the winglets are installed as BFE), 757s, 737 classic models and 727s.

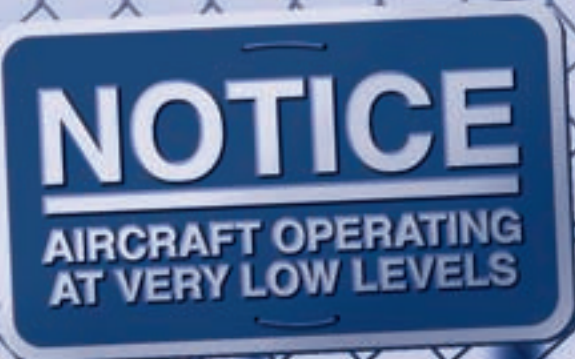


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Demand for the blended winglets is global, with strong orders from the Asia Pacific (recent 737-800 winglet orders from China's Shandong Airlines, Shenzhen Airlines, Air China, and Australia's Virgin Blue) and the US Majors. In April 2007 American Airlines (AA) was named as the launch customer of the 767-300ER blended winglet programme. GKN Aerospace has been selected by APB to produce this 11ft tall winglet as well as the winglet for the 737-300/500.

AA is currently equipping its fleet with winglets. It first equipped a 757 and 737 and flew them to determine if the fuel savings were what the airline expected. Based upon those numbers, it decided to equip its 757 and 737 fleets (77 and 124 aircraft, respectively). Once the 767-300ER winglet is certified, AA will install them on its fleet of 58 767 aircraft.

"American will conserve 17 to 21 million gallons in fuel annually for the 767-300ER fleet. Once winglets are installed on all of our current 737, 757 and 767 fleets, we





will be saving more than 42 million gallons of fuel per year," notes John Hotard, AA spokesman. "Besides the compelling cost savings, the fuel burn improvement also results in a reduction of 423,000 tons of CO2 emissions annually."

Austrian Airlines is the first European airline to order the 767-300ER blended winglets. The airline, which has operated blended winglet technology on 737-800s since early 2005, will retrofit its fleet of six 767-300ERs. Based on their route structure and schedule, APB expects that Austrian Airlines' fleet will experience over five per cent in block fuel savings as a direct result of the 767-300ER blended winglets.

### *The nitty gritty*

A winglet can best be described as a near vertical extension of the wingtip. For maximum strength and flexibility, it is made from a mixture of metal and composite materials. The upward angle of the winglet, its inward angle as well

as its size and shape are crucial for correct performance, and unique in each application. The function of the winglet is to relocate the tip vortex of the wing above and outwards of the normal location. The vortex that occurs at the tip of the new location (the winglet) is considerably smaller, thereby reducing drag and decreasing fuel burn. Winglets also improve the span load distribution of the wing without excessive increase in wing span, thus increasing the efficiency of the wing.

Both blended and straight winglets work in the same way; the principle being to reduce the wingtip vortex and decrease drag. Both types are bolted onto the wing to facilitate quick removal, repair and replacement. Straight winglets are attached to the wing perpendicularly, while there is a gentler curving gradient with the blended winglet. Mike Stowell, the engineering leader at Aviation Partners, explains the reason for this:

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—John Hotard AA spokesman

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“There is a phenomenon called interference drag in the transition area, and anytime you have two airfoils that are perpendicular you run into this. The blending alleviates some of the problems associated with interference drag.”

Quiet Wing Corporation, also based in Seattle, attaches the winglet at right angles to the wing. The company has been in business for nearly two decades and originally started off developing a hushkit for 727 series aircraft. Part of that development was not only to hushkit the engine to meet Stage 3 noise compliance, but also to provide aircraft performance improvements. This involved a combination of a wing modification, based on changing the trailing edge of the flap profile, and the installation of winglets. According to company spokesman Peter Swift, the first use of a winglet on commercial transport aircraft was the Valsan winglet (now

Quiet Wing Corp) on the 727. “Right now we provide winglets for the 727, but the company intends to provide winglets for the 737 classic models. Flight testing will be underway this summer, with approval expected early in 2008,” he says.

In addition to the angle of attachment, another major difference between blended and straight winglets is height. The Boeing winglet is tall, about 8ft high on the 737. The Quiet Wing winglet is about half the size. Swift explains: “We have a patent on the trailing edge modifications that we do and half of our drag reduction and fuel savings is based on changing the camber of the wing. The other half is based on the winglet. This enables the winglet to become smaller, lighter, less intrusive to the wing structure and easier to install.”

Quiet Wing’s target market is focused on areas where older aircraft operate — South America, Africa and parts of



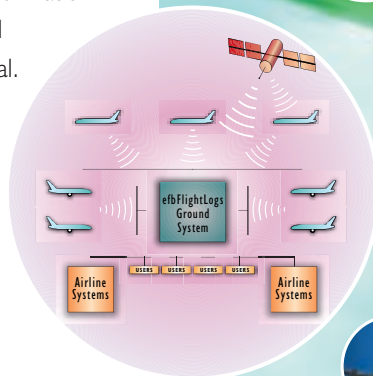
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Europe. Benefits are especially apparent when aircraft operate in hot and high climates, because the system allows the aircraft to use less power to achieve the same amount of lift, resulting in greater payload, fuel reduction and engine maintenance savings. Aviacsa in South America is currently using the system on its 727 and 737 fleet. The winglets are also used by many smaller cargo operators and VIPs. "The range, and payload increase along with improvements in fuel consumptions allow operators to increase revenue substantially," notes Swift. "And of course it looks cool too!"

According to Quiet Wing, the winglet performance kit offers a guaranteed payload increase of up to 8,000lb on a 737 and close to 18,000lb on a 727. Fuel savings are in the range of 3.5 to seven per cent depending on the operator and there are additional benefits of reduced landing and take-off field lengths,

and reduced stall speeds. The cost of a unit uninstalled is \$695,000. The company anticipates delivering 25 winglet performance kits to customers in 2007 and 50 in 2008.

#### *Installation intricacies*

As already mentioned, the Quiet Wing winglet is part of a complete system. When the winglet is installed, the flap settings are changed, the trailing edge of the wing is drooped, as are the ailerons. There is no adjustment of the stabiliser. Installation of the package takes about seven to 10 days. Modification required during blended winglet installation depends on the type and age of the aircraft. Stowell observes that aircraft "require modification on the outboard area just to get the winglet to mate with the wing".

For blended winglet installation, there is also wing strengthening, trim

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—Mike Stowell,  
engineering leader at  
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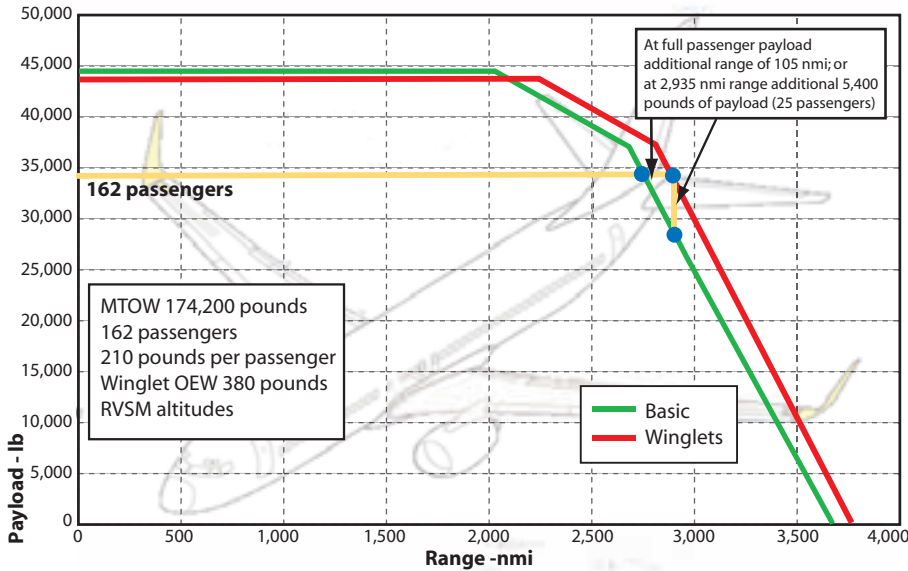
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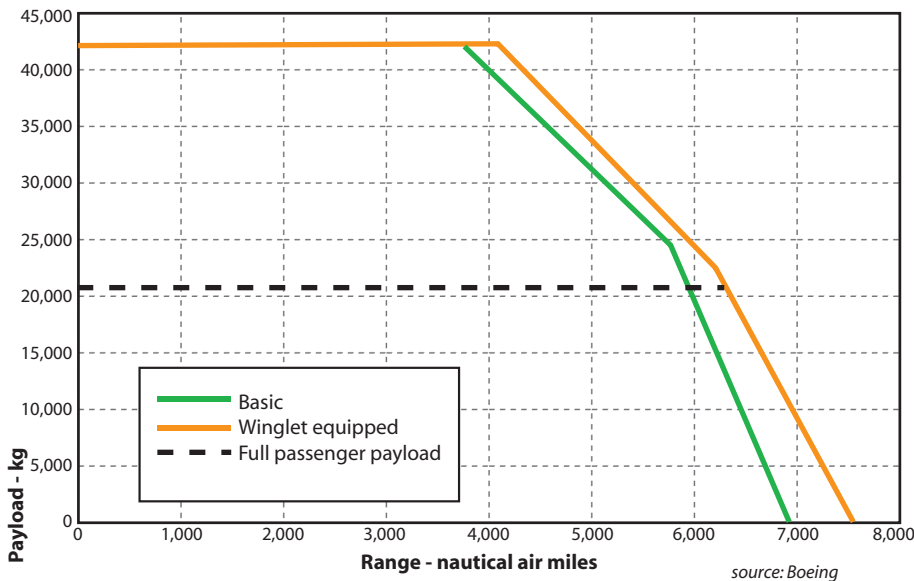
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**Payload vs. range — 737-800/CFM56-7B**



**Payload vs. range — 767-300ER/PW4062**



adjustment on the stabiliser, and load alleviation systems (that affect some of the systems in the cockpit) to take into account. Stowell expands: “Early on in the programme when we were doing retrofit, we did quite a bit of wing modification and strengthening. Then Boeing took our data and actually strengthened the wing in the factory, so we can put the winglet on in the factory or on retrofit. There is less modification required for a stronger wing.”

Depending on whether the wing is strengthened or not, blended winglet installation takes four days to a week. The base price for the uninstalled winglets for the 737-700/-800/-900 is \$850,000, the 737-300/-500 is \$550,000, the 757-200 is \$900,000 and the 767-300ER is \$1,850,000.

Very little pilot retraining and maintenance adjustment are necessary after winglets have been fitted. There is no required simulator training and pilots only need to familiarise themselves with changes in the manuals. Essentially, the aircraft operates very close to the levels it did before it had winglets. “Our programme objective is not to affect the normal operations of the airplane or impact the maintenance programme,” says Stowell. “It is still very much the same type of airplane, but you enjoy the benefit of winglets.” Maintenance is at the same intervals as those of the aircraft before installation. Inspections for winglets are usually in combination with inspections required on other parts of the aircraft, using the same methodology.

*The long view*

Bryson Monteleone, chief marketing officer for Morten Beyer Agnew (mba) international aviation consultancy, says that from an appraiser’s perspective, aircraft such as the 737NG now have winglets as standard — so any of that type that does not have winglets gets a negative adjustment. However, for aircraft such as the 757, where winglets are not standard, there could be an enhanced residual value. “But it really depends if that aircraft is in demand, and if an aircraft can be easily adapted into a fleet of aircraft that does not have winglets,” he stresses. “Most of the time it comes down to commonality with other aircraft and fleet integration.”

With each model that is developed, the design of the winglet is tweaked. There are always changes, advances and improvements. In Stowell’s opinion the latest blended winglet for the 767-300ER is the best

performing winglet that APB has ever designed.

“We are continuing to improve our winglet technology. We are looking at some different tip devices. The 737-900 and -500 blended winglets are in development. We expect to have an STC for the -500 in June 2007 and for the -900 in the fourth quarter of 2007.”

APB has a firm backlog that stretches to 2014 for existing products. In terms of orders and options, the backlog is currently over 3,000 units.

Other manufacturers are also considering the potential long-term benefits of winglets; they were the focus of a 2006 research programme for the Airbus A320 family. After extensive testing, both the in-house design and a second from Winglet Technologies were rejected because the extra weight necessary to reinforce the wing structure negated the aerodynamic advantage. At the

Airbus Technical Briefing in Toulouse in April 2007, it was confirmed that Airbus is still looking into winglets for the A320 family and it is rumoured that they have approached API.

Although winglets are a welcome fuel-saving addition for airlines, there are some hurdles in the path of winglet manufacturers. The certification and accompanying costs are definitely a challenge. APB expects an eight month flight certification process for the 767-300ER winglet. Another challenge is that technology is currently focused on materials (composites). One cannot change the whole structure of the older aircraft to install winglets. But as new technology develops, additions to the aircraft will become lighter, simpler and cheaper. With regards to new aircraft, there is little doubt that winglets could soon become standard for cost-conscious airlines. ●



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