Spinning a Lancair IV is not recommended. Few pilots have lived through the experience. Not one of them would care to repeat it. Having spent 42 months of hard labor on a Lancair IV project in Salt Lake City, my brother and I were in no mood to commute that into a death sentence. We approached each stall gingerly, from level flight, one knot at a time. Despite being one of the lightest of the type to fly, we grumbled at a seemingly high stall speed—72 knots. The stall always broke sharply to the right, with a subtle warning a few knots before. We tufted the wing and observed a powerful inward flow, from wingtip to fuselage, along the trailing edge, just prior to the stall. This span-wise flow would become turbulent near the wingroot, then abruptly spread across the entire wing like a big table cloth, all the yarn tufts swirling and twisting like fur on a cat rubbed the wrong way.

The presence of the yarn tufts added visual drama to the very complex airflow over the wing near the stall. In level flight, the yarn pointed steadfastly aft, barely wiggling at all, uniformly painting the picture we've all seen from the beginning—airflow passing over an airfoil, the airplane feeling solid and fast. As the stall approached, however, individual tufts of yarn began to twist and point in surprising directions—most inward, some straight up or even forward! The majority of turbulence began at the wingroot and burbled away to strike the tail, felt as a mild buffet. Shortly after, and a few knots slower, the right wing would fall away as though it were sliced off. With a quick response and a typical stall recovery technique, the wing...
drop could be controlled to less than 60 degrees. Caught unawares, a pilot could easily find himself inverted.

We guessed the span-wise flow seeded the turbulence that led to the full stall. Prevent the span-wise flow, and maybe the stall could be delayed? This resulted in some nifty looking fences on top of the wing, positioned between the aileron and flap. Flight testing proved the stall came four knots slower, but without any warning at all. Aileron control authority seemed to improve leading up to the stall, then wham! Over she goes. We debated the merits of slower speed against lack of warning, eventually keeping the fences in place, with the understanding that under any circumstances, the plane could bite hard if allowed to stall.

Different Plane, Same Results
A short time later, another Lancair IV owner asked me to perform a stall series on his airplane. We found the same results: little warning, and a sudden break with a pronounced right wing drop. Literature from Lancair suggests that asymmetric stall behavior might be corrected with careful application of stall strips, at the expense of a slightly higher stall speed.

Twenty years later, that first Lancair IV has flown about 1500 hours, taking its owner to and from his several properties in pressurized comfort. It is surprisingly economical, reliable, and as the advertising suggests, very fast. The second Lancair had an unfortunate accident a few years after construction when an engine failure led to a forced landing short of the runway. The owner survived, but the plane was a total loss.

The FAA expressed alarm at the disproportionate number of stall/spin loss of control accidents in the type and issued a letter suggesting installation of angle of attack measuring/warning equipment. This is not a bad idea, considering the type’s atrocious stall behavior. A combination of good stall warning equipment and careful pilot technique may easily prevent the stall/spin accident. Similar tools have worked for decades in most airliners. Very few of them have decent stall characteristics, and are thus prohibited from slowing down by a slew of stall computers, stick shakers and control pushers. These work collectively to bring a speed issue to the pilot’s attention—sort of a big red light and blaring horn to affirm the old adage, “Thou shalt maintain thine airspeed, lest the earth rise up and smite thee.”

Help From Sailplane Enthusiasts
Vortecx Industries, LLC has developed a better solution. John Neel and
York Zentner, two gentleman pilots with a soaring background, and David Colling, an aero-engineer, wanted better performance from their sailplanes. From a design standpoint, a sailplane has far fewer variables than powered aircraft. No propellers, P-factor, exhaust, cooling, fuel tanks, fire concerns, pressurization, range/endurance, anti-ice systems, radar, and the like to concern with—just wings, control surfaces and a place to sit. Package everything in the lowest drag shape imaginable and hope for some lift. Soaring is one of the last bastions of the aeronautical purist.

Traditionally, increased soaring performance has been directly proportional to wingspan. Longer wings equal better lift to drag. Practically, however, longer wings make trouble of their own kind: Simply banking into a turn becomes a sort of argument, with the pilot madly chasing errant yaw strings all over the sky. One of the most competitive categories limits the sailplane wingspan to 15 meters—fairly sporty to fly, but somewhat lacking in performance when compared to open class gliders. When challenged to improve an older 15-meter sailplane for equivalent performance to modern (expensive!) ships, Neel and Zentner found solutions in a clever set of winglets. They planned for the optimum outward cant of each winglet, only to discover the tips reached slightly past the 15-meter limit. Rather than shorten the wing, they built a secondary break in the winglet, a sort of polyhedral evident in the pictures. Serendipitously, this little change in angle resulted in an unexpected increase in performance. Flight characteristics improved drastically, to include better yaw stability and greater aileron authority. Although at first teased about the tall tips (Compensating for something?), the client found delight soaring right along with competition sailplanes costing three times as much. His modified glider could climb, turn, and run with the best. Vortecx obtained a patent on the concept and went to market.

Installation on a Lancair IV-P

When Roland Manarin of Omaha, Nebraska, requested winglets for his beautiful Lancair IV-P, Vortecx Industries went to work. David ran computerized finite element analyses on the winglet as applied to the Lancair, using state of the art software. The winglet is a complex mix of different airfoils and fixed incidence angles carefully tuned to an individual airplane. The winglet needs to be perfectly aligned with the wing and airflow in order to work effectively. The limits are tight, just two tenths of a degree. Simply bolting the winglet to the tip might result in truly terrible consequences, and make the airplane difficult to fly. The Lancair is nicely modeled on the computer—basic information like wing loading, horsepower and the overall shape of the aircraft are easy enough. The plot thickens considerably, however, with the fact that no two homebuilt aircraft are exactly the same. This is true, to a lesser degree, of factory built airplanes, as well. As such, York and John faced the problem of achieving perfect alignment on an airplane with no flat surfaces and unknown construction accuracy.

To begin, the wingtip required reinforcement. This particular plane allowed for a small spar extension to fit, grafting the large winglet loads into the path already carried by the main wingspar. On other aircraft, the wingtip flange itself might be reinforced with liberal use of carbon fiber until able to sustain loads generated by a large vertical surface.

Curious about exactly how much load the wingtip mount screws could take, Cal Poly University composite labs tested several examples to destruction.
In each case, the screws failed before the composite material, with each #10 screw withstanding about 1100 pounds before shearing. With screws every few inches, all the way around the wingtip, the winglet effectively becomes a structural extension of the wing and can take tremendous flight loads without failure.

With the plane leveled and blocked in a clean, enclosed hangar, York and John carefully measured the airframe using lasers, trammels and plumb bobs to determine an accurate centerline reference, which they marked on the hangar floor. More measuring to determine wing alignment and incidence, with corresponding marks on the floor, followed. Moving outward, the team arrived at the wingtips with a good sense of local airflow as pertaining to that particular aircraft. Some educated guessing followed, involving several custom protractors and measuring tools, as to perfect placement of the winglet. From there the winglet was painstakingly cut to fit. The process is iterative, with each cut followed by more measuring, another cut, more measuring, and so on, until the alignment falls within the .2 degree allowance, roughly the width of a Sharpie line drawn on the floor.

**Flight Testing**

Flight testing followed, with oil flow tests and video recording to examine actual airflow across the winglet. Subtle adjustment at this point helps dial in optimum performance. Figure 1 shows measured performance on Roland’s airplane before and after the winglet installation. Video of one of the performance flights is posted online; search Vortecx winglet.

While lowering the stall speed significantly, the winglet seems to have little detrimental effect at high speed. Indeed, with increasing altitude, the winglet enhances both rate of climb and cruise speed. Above FL200, the performance gains become very significant—20 percent faster cruise and near doubling the rate of climb! These are remarkable numbers, considering the Lancair IV is already one of the highest performing Experimental types available. Throttled back slightly, the winglets enable substantial fuel savings with no loss of speed over the stock aircraft. This might translate into significant fuel savings year over year. York indicated that these results are typical of most aircraft fitted with the Vortecx winglet.

**My Turn**

After hearing all the hype, I looked forward to the opportunity to fly a set of these winglets myself. No stranger to the Lancair IV-P, I felt confident evaluating its performance and handling, particularly in relation to stall behavior as affected by the new winglets. York felt confident, too. He brought his son Parker along for the demonstration. They arrived at South Valley Regional Airport
(near Salt Lake City) looking and sounding very much like any other Lancair. As the plane slowed on approach, however, the distinctive winglets seem to grow bigger and taller. They are not small. I wondered if they disturbed the view from the cockpit. I also wondered if they affected handling much at high-yaw conditions in flight. York assured me that they could handle any side load in flight without failure, and that I could play with the rudder all I wanted.

Roland Manarin’s airplane is beautiful. Very well finished with excellent paint and a lovely interior, it is typical of the high-dollar efforts most builders put into their Lancairs. The winglets blend perfectly into the wings, tastefully painted to match a fairly elaborate paint scheme. A delightfully complicated pattern of LED lights crown the tips for nav and strobe functions, and the leading edge sports landing lights on both sides. The winglets are beautifully made, with excellent fit and finish to match the best of composite construction. The instrument panel carries a mix of old and new, with a Dynon EFIS replacing the altimeter in an otherwise standard flight director/HSI instrument package. All the instrumentation, finish and finery adds up in weight—about 438 pounds more than the plane we tested 20 years ago. Winglets might be especially advantageous in this circumstance, as they help the wing fly more efficiently. From the cockpit, I observed the winglets do not intrude into the field of view. They sit far enough to the side that you have to turn your head a bit to see them. Even looking at them directly, they do not seem as big from inside the plane.

**Takeoff and Basic Maneuvers**

Loaded with some fuel and three occupants in an already heavy airplane, I expected to roll for a good long while on the pavement. Lifting the nosewheel slightly, the airplane surprised me by floating off the runway and climbing much sooner than I expected. The wing felt powerful from the beginning, climbing strongly before we had much speed on the dial—unusual and better than a stock Lancair. Immediately apparent, however, was a degradation in control harmony. The Lancair IV controls do not harmonize well. It is light and sensitive in pitch with relatively heavy ailerons. Winglets make the ailerons more powerful, but they feel heavier, exacerbating the unbalanced relationship of the controls. Putting some muscle into the side stick, the same roll rates could be achieved as without winglets, but I suspect an airplane with winglets would be rolled slower in general due to the heavier feel. This is not a major issue, as the airplane is not aerobatic. The heavier ailerons lead to a feel of greater roll stability, and the plane seems to want to go straight—just like a proper traveling machine should. As usual, any change in attitude, speed or power setting sent the rudder ball to one side or another, and required near-constant adjustment of the electric rudder trim during maneuvers. This is common to airplanes with big, high-torque engines. Once set up for cruise and carefully trimmed, however, the plane is easily managed for long flights.

I sampled the rudder during our cruise to the flight test area. I suspected the big winglets might develop noticeable side forces at high angles of yaw, or beta. They certainly increased the roll coupling with rudder input. The
plane could roll on rudder alone, if you didn’t mind the inclinometer diving off to the side. It was much like a sailplane, in fact. We noticed some instability at high beta. At some point, the plane wanted to break away on its own, trying to rapidly increase yaw with no further input from the pilot. I suspect this is caused when the winglet on the side dragging behind reaches sufficient angle of attack to generate lift across its outboard surface. From the cockpit it feels like a little parachute suddenly deploys on the wingtip. I could correct the attitude immediately by releasing rudder pressure, but the tendency to snatch to one side surprised me. York noted that this occurs at angles of beta much higher than normal. I agree, but suspect the plane might benefit from a big ventral fin and rudder extension to improve yaw stability.

We observed no speed degradation in level flight at high speed. With so much increased area out there, I felt that something had to slow down. Apparently not. The winglet contributes a little thrust component of lift, negating any increase in form drag.

**Stalls**

We climbed to 9000 feet msl to sample stall behavior. I made a gentle reduction in speed, gingerly feeling out the controls. Aside from a general softening of the control response with reduced speed, the airplane continued as it had before. At 75 knots and carrying a little power, the plane began to buffet audibly and through the controls. Surprisingly, the ailerons continued to be effective, with gentle control inputs able to bank left and right, at will. Full stall came with a break to the right, as usual, but a good deal less than I remember. With practice, I could make it break straight ahead—a huge improvement over the “stock” Lancair IV. This particular plane stalled a little over 70 knots—about the same as the plane we flew 20 years ago. York indicated that the increased weight of the empty airplane had it stalling quite fast to begin with—over 80 knots, and that the winglets in general seem to offer a 10-knot stall speed reduction with improved control authority and better warning, to boot. Not a bad solution.

Delighted with the improved stall behavior, I probed a little further with York’s enthusiastic approval. A 2G turn to the left resulted in an accelerated stall that broke back to level flight as it recovered. Astounded, I performed the same maneuver in a right turn...

**There It Goes!**

At stall, the airplane immediately snapped to the right, spinning rapidly, without provocation. The spin continued despite the application of full opposite rudder and lowering the nose. We rotated about four times to...
the right in a strange unloaded spin, as speed degraded. York said, rather calmly, “Get the nose down,” about the same time I applied full forward elevator. We had some success lowering the nose, when the plane promptly snapped over to the left for a couple of rotations and assumed a near vertical attitude. Shortly afterwards, using very aggressive control inputs and a little patience, we recovered with a loss of 4000 feet. Throughout the unexpected event, the atmosphere in the cockpit was very calm, almost casual, although it had our full attention. When everything settled, we felt quite rattled.

In retrospect, that was a near worst-case scenario. We were heavy, with an occupant in the back seat. I doubt the average Lancair IV could have recovered in time. The winglets, then, made a difference between life and death, but are not foolproof. This fool went poking around the stall with too much confidence in the new handling, and got bit.

**Conclusion**

The Lancair is a very high-performance airplane with a bit of a reputation. The Vortecx winglet offers significant performance gains at both ends of the envelope, while taming the stall behavior. The modification adds 20% to the high-altitude cruise, a 10-knot reduction in stall speed, better takeoff and landing performance and better stall warning. Vortecx plans to develop a larger fin and rudder, which might tame the airplane’s low-speed behavior entirely. It’s almost unheard of to make a plane faster, slower, and safer with the same mod, but there it is.

Vortecx has been developing winglets for years, each improving on the last. The next generation will accomplish the same performance gains at about 70% the current size. They have installed custom winglets on a number of aircraft, including various homebuilts, sailplanes, and even a Citation jet. In each case, substantial performance gains occurred.

Not every airplane type is a good candidate for winglets, however. Some designers do an excellent job with the wing already, but they are the minority. Vortecx modifications are aimed at designs where money is left on the table, so to speak, where performance enhancements pay big dividends. Their services are not cheap. A great deal of design work and labor, and a couple of weeks with the airplane add up in costs.†

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**Lewis Bjork**

Lewis Bjork has constructed many airplanes, authored a few books and numerous articles. He enjoyed flying for SkyWest Airlines the last twenty years, and is married to Linda, a very patient wife. They are the parents of five children.

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