Lancair Legacy HB-YMS flight tests with Vortex Generators by Viktor Strausak

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After the Lancair Legacy with a turbocharged Lycoming 210hp engine was 3 decibels too loud for the lowest noise class A at the EAS noise measurement in Switzerland (According ICAO Annex 10 Chapter 16 noise limits).The same type with 310hp engine achieved the best noise class D most probably due to better climb performance.

I now try to reduce the noise in an unconventional way to increase the climb performance with vortex generators and extensive test flights. I would like to mention that I have never flown a Lancair before. According to Lancair pilots I expected an extremely difficult and demanding flight behaviour. Before my stall test flights I was warned by legacy pilots of the very dangerous stall behaviour, especially at full throttle. I was amazed of the high approach speeds of 90kts at the beginning and in the final not below 80kts (according to AFM), because otherwise you may loose the lateral control.
I approached the test flights with the beautiful Lancair Legacy with a lot of respect and caution.As with all my stall test flights before, the first thing I did was to tape black wool threads onto one wingside. This allows me to observe the airflow over the wing at all speeds up to full stall, initially in its original condition without VGs.

First test flight without VGs: aileron ineffective below 80kts

It became clear to me during the first stall attempt why Lancair pilots force their aircraft onto the runway for landing without flare to reduce the speed. **The aileron is wrongly constructed and stalls below 80kt.**

Already at 78kts I made full aileron deflections without the wing moving - the aileron lost its effect and therefore its function.During take-off the aircraft is only controllable with the aileron from 80kt. Fortunately this dangerous flight phase is very short.I flew the Legacy in all configurations with idle power and max power until full stall, including gear down and full flaps. I was advised not to stall with max power because it can become unpredictable. I did it anyway and survived!
After my first evaluations and experiences with the wool threads on the beautiful and elegant wing shape, it became obvious that the aileron had no airstream and was ineffective below 80 kt, aerodynamically not optimal. I experienced a dangerous behavior in the stall, my suspicions have been confirmed. My medicine: Vortex Generators! VGs.

For the attachment of the VGs (with doubleside 3M adhesive band) we made a special cardboard gauge for this wing shape, with smaller distances than usual of only 50mm and the 15 degree angles alternating exactly from flight direction. Initially we attached only the outer VGs far forward at 7% of the wing depth in front of the ailerons.

In addition we mounted a row of VGs underside the elevator with 30mm distancing and 100mm in front of the hinge. As with many airplanes the elevator is too small and has too little effect when landing at low speeds.

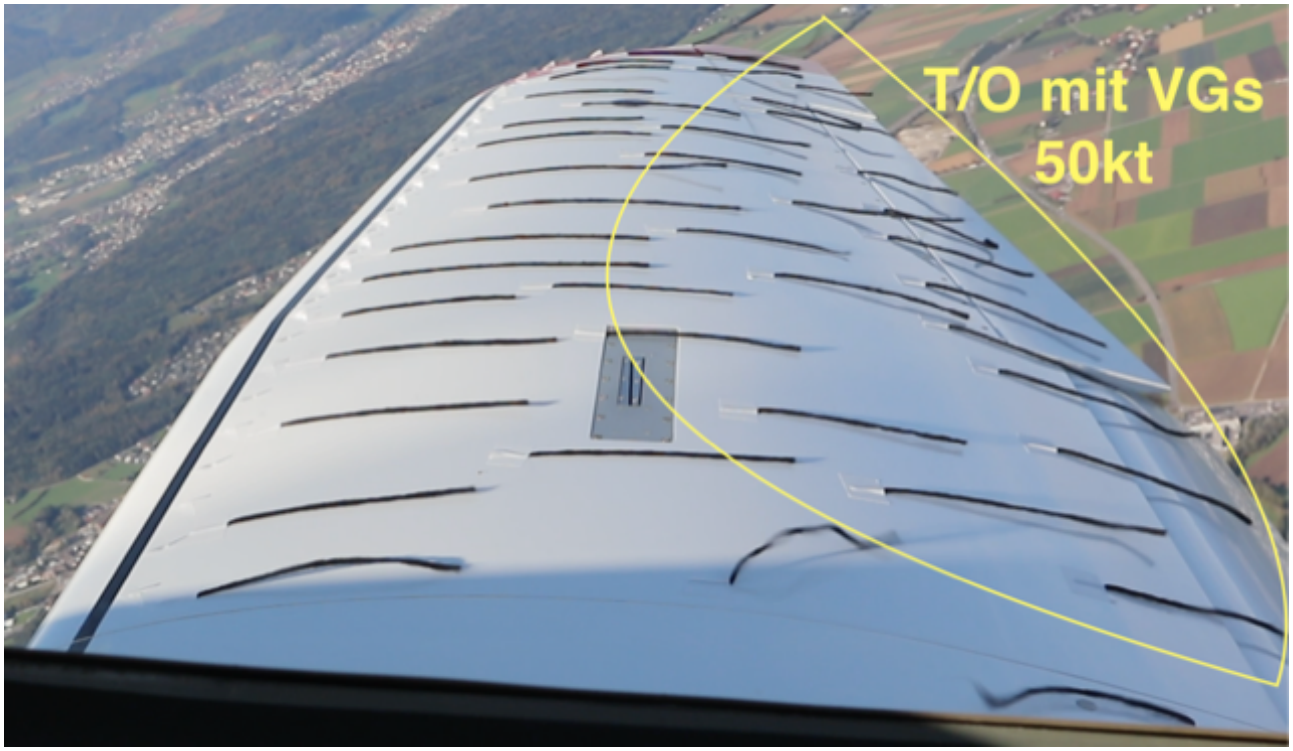
The second test flight with VGs only on the outer half of the wing, in front of the aileron, was a complete success. The plane remained fully controllable until full stall and the stall speeds were already much lower in all configurations.

Now we glued the VGs also on the inner half of the wing with 90mm distance. The larger distance between the VGs causes the flow on the inner wing to detach before the ailerons become ineffective.

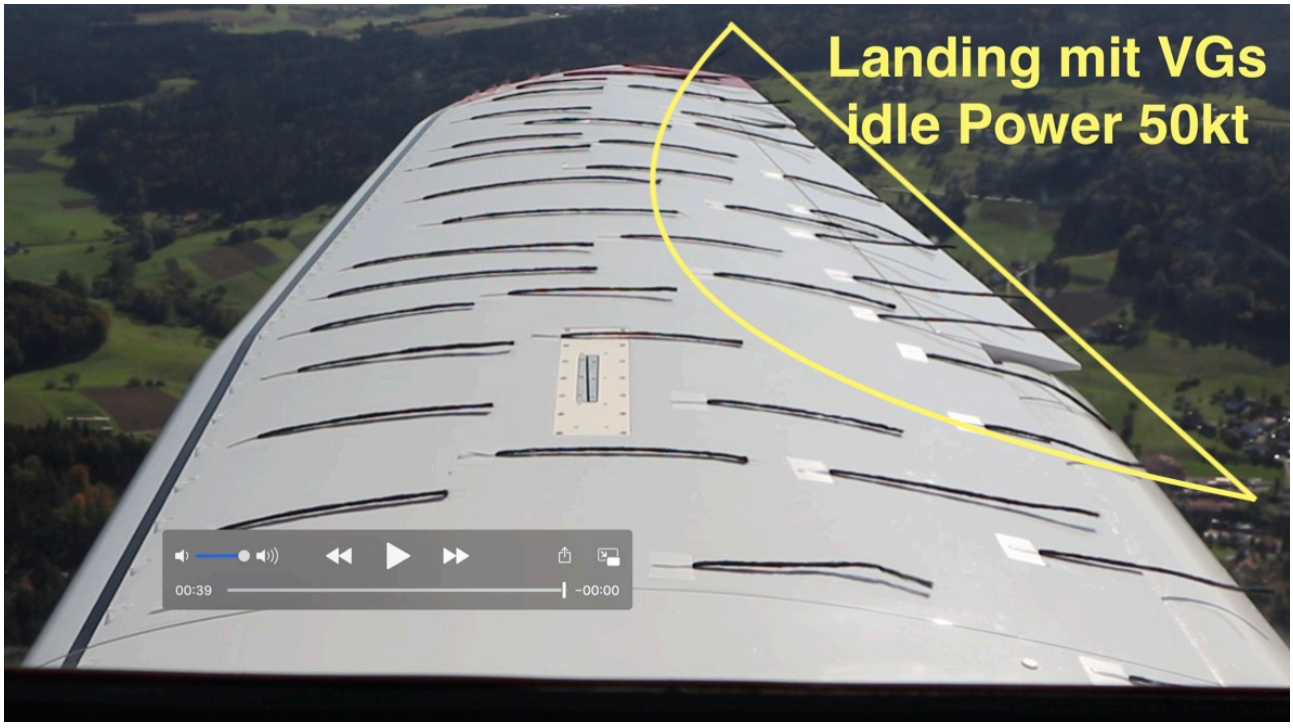
Third test flight:
I was impressed and enthusiastic about the success, my expectations were far exceeded! The airplane has always well behaved and was controllable in stall and the ailerons always remained effective. We were able to reduce the stall speed up to 15kt (-22%) and this with full aileron control!

The touch down speed of 80 kt without VGs, became now 55 kt to 60 kt! A Reduction of 20 kt to 25 kt (-30%) !!!! The landing distance became massively reduced to less than 400m.

T/O configuration with max power from 50 kt the ailerons are fully effective, perfectly controllable! Before 80 kt!



Landing configuration with 50kt perfectly controllable! Before 80kt!



Go around with 44kt perfectly controllable! Before 80kt!

Changes with VGs:

Rotate before 60 kt at the start and initially climb with 65 kt.
T/O roll distance new about 300m.

Without VGs the plane was not steerable below 80kt.
As a feeling the rate of climb increased by about 200ft/min and the cruise speed remained unchanged. These values still have to be verified. For me the Lancair Legacy modified with VGs has become a very pleasant and easy to fly aircraft, which can be operated from relatively short runways without any problems. So this Lancair has become a "normal" aircraft, which is much easier to fly than e.g. a Kitfox with tail wheel (takeoff and landing).
I hope that as many Lancair pilots as possible will use our experience to make their Lancair Legacy a "real" and **safe aircraft**.
With such expensive airplanes the effort of about one day of work and material costs of $ 162 should not be an issue.

Position of the VGs:
Front edge of the VGs to 7% of the wing depth. Distance inner wing 90mm. Outer wing forward of the ailerons at 50mm distance. The angle is always 15 degrees off the airstream, alternating left and right seen in flight direction. Set the VGs on the outer wing with it's 7 degrees trapezoid also at 15 degrees off the airstream.
Underside of the elevator 100mm in front of the hingeline, distancing 30mm, at 15 degrees off the airstream.

Approximate Changes by the VGs:
Approach speed 65kt, -25kt (-27%)
Landing speed 60kt, -20kt (-25%)
Start roll new approx. 300m. Landing roll much shorter than before, under 400m. Stall up to 15kt (-22%) lower.

The aircraft always remains controllable with **very good handling in stall.**
My recommendations how to equip and fly a Lancair with VGs: **Every pilot has to test and fly these values with his own plane at his own risk.**

Start: At 58kt, rotate controlled and fine, then climb with 65kt at the beginning. To prevent any overrotation at take off set the trim to slightly nose down for the light 210hp engine.
Landing: Downwind clean with 90kt. Base gear and flaps down speed initially with 75kt. Stabilized final 65kt, with training in short final even 60kt possible. Landing distance under 400m!
Caution: Reduce to idle power late and slowly and rotate simultaneously as the speed drops rapidly. Beware of short landing and hard-landing!

Conclusion: During the test flights we had a lot of fun and the results exceeded my expectations by far.
The EAS www.experimental.ch test flight program has to be flown again and the AOM data updated. Then the sound test in Switzerland has to be done again with the new values.

The Vortex Generators are from STOLSPEED Australia. www.stolspeed.com
It takes about 200 VGs for $162.

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