

The Leading Edge

In Search of STOL

My Highlander has always performed well whether I am cruising with floats at just under 100mph or landing in the most unusual places with my large bush tires. But... like most pilots and builders, I wondered what tweaking would be required in order to improve the performance of my aircraft.

Many pilots define performance as how fast the plane flies given its available power and efforts to improve performance focus on cleaning up the airframe by adding fairings and streamlining the aircraft. Seaplane pilots consider performance in terms of how fast the plane gets off the water and over the trees or hills along the shoreline. Bush pilots and other STOL operators consider takeoff and landing distance as the primary performance measures. Since I operate in all of those environments, expanding the envelope of speed between stall and wide open throttle is my goal.

Several of my Highlander friends in Western Canada and United States have been experimenting with "mods" that they claimed vastly improved the stall speed of their planes. I have been considering for some time now whether to try a few of them to see what difference it might make on my own plane.

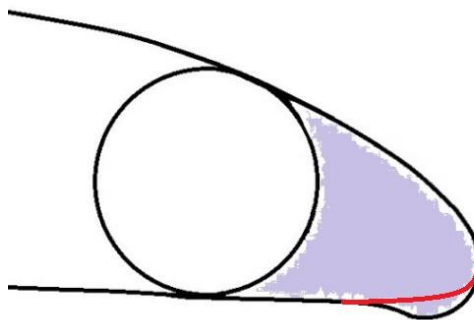
Some of the more common modifications like flap gap seals and vortex generators had such amazing claims being made about them that I installed them when I built the plane. Some of the more exotic changes like wing extensions, leading edge cuffs, and double slotted flaps would require a fair bit of planning, preparation and manufacturing of special parts to accomplish the task.

I have been considering trying a few of these options for a few years now and the feedback from other Highlander owners indicated the best gain was achieved by installing leading edge cuffs with a slight droop. Once I decided to try this option, the second decision was just how big to make them. Steve Henry (the Dead Stick Takeoff guy) in Idaho installs a small leading edge bump out that is less than an inch deep and uses them full span on the extended wings of his Highlander. Steve claims several miles per hour reduction in his stall speed as a result.



Well... if that little strip makes such a big difference what about a thicker bump-out on the cuff? I mean... if a little bit is good, then a lot has to be better... right? Another acquaintance in Alberta sent me photos of the cuffs he added to his Highlander. The cuffs had been made to extend the front of the wing by about 2.5 inches and also introduce a small droop at the leading edge. Rick claimed his cuffs dropped his Highlander's stall speed by about 7 mph...Wow!

With a current stall speed of 40 clean and 34 mph with full flaps, the promised drop of 6-7 mph was just too enticing not to try it. So, I had Rick send me some photos of his leading edge and the tooling he used to form the aluminum. I spent a couple of hours on the phone, discussing how to make the cuffs and how to position and fasten them onto the Highlander.



One of the designs that has always impressed me is a Harry Riblett design based on the Clark Y airfoil. By adding the small droop shown below the red line, it should give me the performance I am seeking. This is very close to what Rick did on his plane.

Adding 2.5 inches increases my wing area by 5%, so theoretically it should also decrease my stall speed about 1 or 2 mph. (with the droop, hopefully more)

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One of the big challenges is that the leading edge of the wing is actually the front spar, so drilling and riveting was out of the question. I certainly didn't want to impact the integrity of the aircraft when trying this experimental addition. Another big challenge was that I lacked the heavy equipment to press the 8 foot sections of aluminum into the shape I required. I decided to try 4 foot sections, which were still a challenge and settled on 3 foot sections, which I managed to bend with a little effort and ingenuity.

Rick had sent me some photos of his wooden jig, which he made from 2x4s and I used them as a general idea of how to make my own forms for bending the aluminum. I designed a jig that I thought would easily bend the light .016 gauge aluminum, but found out it was a lot trickier to bend a compound curve than say a simple straight 90 degree bend.



In the end, I found that I had to hammer the upper form into the lower one with a rubber mallet while applying significant force from my body weight to get the aluminum to conform to the curve within the tight form I had made. But, it did work! I was able to reproduce the curve to make enough pieces to form the new leading edge.



To get the droop, I had to reposition the upper form and using a long dowel, re-drove the upper form into the lower one with the aluminum off to one side. The trick here is getting the curve consistent through multiple pieces. But careful planning and measurement paid off.



Installation was going to be tricky, but the information I received from Rick made it sound like it was quite possible to fasten the pieces without using a single rivet. I made a few identical curved blocks from balsa to hold the forms in position on the leading edge and a couple of reverse curve templates that I lined with foam weather stripping. I was able to position the pieces within close tolerance of each other by wedging the aluminum pieces in place one at a time and, after taping the upper and lower edges, filled each end with low expansion foam; the type used in window and door installation.



I waited several hours between sections to allow the foam to set up. Once completed, I trimmed off any excess that had seeped out and installed coloured vinyl over the entire length of the leading edge to match the paint on the plane. I then trimmed out the installation with a little reflective gold vinyl like I have on the rest of the plane to make the installation look like it has always been there. I was very happy with the

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finished product, but the real test is in the outcome, not the look! I was hoping to get a 6 to 8 mph reduction in stall speed... time will tell.



Not long after, I had an opportunity to fly the plane with the mods done. I carefully applied throttle and eased the stick back to get off the ground, accelerating in ground effect, I gently applied a bit of aileron back and forth... everything seemed pretty normal so I gently climbed away and flew a circuit, checking the handling and then returned to the ground. I checked the condition of the mods and found everything was just as expected.

Next, I took off and headed away from town to get to somewhere safe to try some stalls at altitude. The stall was very docile, but not much slower than before... if at all. I performed several power-off stalls and the results were the same. I then tried high speed flight and although it was starting to get a little windier, it seemed like I may have lost a couple of miles per hour. I decided to land and test it again another day.

I called and talked to Rick to let him know what results I had from the new cuffs and he was surprised I had not noticed a substantial difference. We discussed moving the vortex generators (VGs) forward 2 to 3 inches and figured that would help.

I spent several hours the next day carefully removing the VGs and repositioning them with double-faced tape in their new locations. The stall test flights were again underwhelming, especially since I did a longer flight of about one half hour each way and felt like I was slower than before the changes. With the weather being what it was this last couple of weeks and

me getting a cold, I haven't had another opportunity to try them again.

This little experiment in STOL capabilities is just one of the reasons I really like having a plane in the amateur-built category. If I like the changes, they will stay on, but if I don't I can remove or modify them until I get the performance I am looking for. Having a large community of other Highlander builders in the US experimental category is a help in knowing what is possible and what works well for others. On this side of the border, it's great to have a local community of builders in RAA with aircraft of different designs and ideas on how to improve STOL performance.

Like every pilot, I love flying, but always wonder about what it would be like if a tweak was made in some system on the plane, but it's also important to keep safety in mind and have a good knowledge of how any modification is likely going to change the handling characteristics of the aircraft. In this case, I had first-hand accounts from other builders who related their stories of improved handling characteristics before I even started on the project, otherwise I likely wouldn't have even considered trying this modification.

In a late development, this just got posted on Steve Henry's thread on the Wings Forum in response to someone else's query and wing extension photo... *"When you are using the LE cuff you really need to get your VG's as close to the cuff as you can get them. Where you have them is a good place for them with no cuff but they are nearly useless there with the cuff on. The cuff-VG combination worked much better for me when I moved the VG's just behind the cuff"*.

With this new information, I may move the VGs even farther forward and try the plane that way before giving up on the leading edge cuff idea. I noticed that on Glen Mair's C150M they are only 2" from the leading edge and basically right on the cuff. I'm still hopeful I can get the decrease in stall speed I expected, but I need to get a little more time in the air to confirm things. I'll keep you posted on how it works out... maybe I will modify them a bit or maybe I will just remove them if I don't see the changes expected... again, time will tell! ☺

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Upcoming Events in 2019: (Highlighted lines are KWRAA Events*)

June 6-8	-	COPA National (Western) Convention in Innisfail, Alberta (CEM4)
June 15	-	KWRAA Largo Woods Fly-in near Winterbourne Info
July 6	-	KWRAA Fly-In – Jergenson Field – Arthur Info
July 13	-	Zenair Open House – Midland at CYEE - Huronia Airport
July 22-28	-	Air Venture Oshkosh in Wisconsin, USA
July 27	-	KWRAA Fly-In at Wilf Holyoake's near Belwood Lake (Tentative) Info
August 10-11	-	Gathering of the Classics in Edenvale
August 16-18	-	UPAC Convention – Lubitz Field, Plattsville
August 17	-	Aviation Fun Day at CYKF – Waterloo Region International Airport
August 22-24	-	COPA National (Eastern) Convention Cornwall Regional Airport (CYCC)
August 31	-	KWRAA Fly-In at Roger Deming's – Kenilworth Info
September 9	-	September Meeting at 7:30 in the Cadet building at CYKF
October 21	-	October Meeting at 7:30 in the Cadet building at CYKF
November 11	-	November Meeting at 7:30 in the Cadet building at CYKF
November 29	-	KWRAA Christmas Party – Details to follow later in 2019

* KWRAA events are fly-in and/or drive-in.

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All metal with fabric covered fuselage is ready for instruments and 100hp engine. Built to plans with exceptional build quality.

Replacement parts cost (unassembled) over \$30,000 USD

MDRA Pre-cover inspection was done in June 2011.

Asking \$18,000 USD

Please contact Clarence for more information ... cemartens at rogers.com or (519)742-3159.

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Corvair Engine set up for aircraft use, but easily converted back.

Contact Clare Snyder for more details and price. clare at snyder.on.ca