Lancair 320/360 Small (Original) Tail Trim Tab Modification

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The original small tail trim system used a bias spring to apply a force directly to the elevator push rod. This is simple system in that it leaves the entire elevator intact. There have been a few variations of the actuation mechanism and springs used stemming from operational difficulties. Stiffer springs and alternate means of holding the trim position lever have been devised and employed.

One of the drawback of this type of system is that it adds a degree of pitch instability to the aircraft. This is caused by the decoupling of the trim input from airspeed. Hinge moments on the tail are a function airspeed while the force imparted on the elevator by the spring is not. The plots below show this interaction in a simple phugoid maneuver. The phugoid is a gentle back and forth exchange of kinetic and potential energy. Figure 1 shows the phugoid with an original spring bias trim system. The period very short and the damping is minimal. Figure 2 shows a phugoid of an original small tail with the spring removed and a trim tab added. Note the lengthening of the period and the pronounced decay.

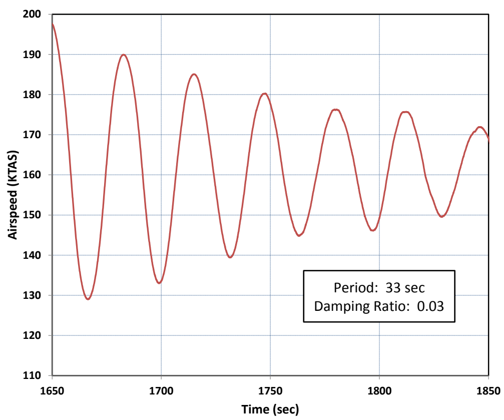

Figure 1, Original Tail, Spring Trim System

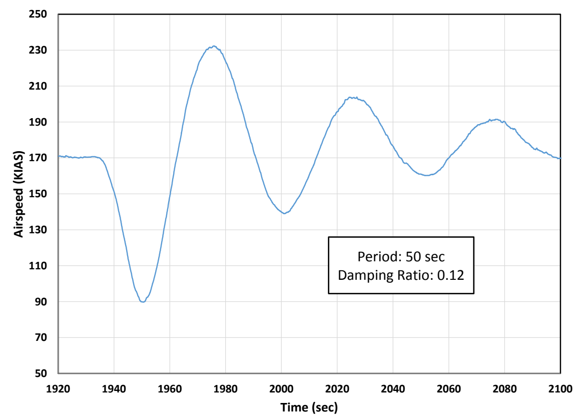

Figure 2, Original Tail, Trim Tab

Figure 3 and Figure 4 provide more insight into the influence of the spring. These plots include angle of attack as well as elevator input. This maneuver is flown stick free, so the elevator is free to float. The spring bias trim system however imparts an elevator input as the hinge moment changes with airspeed. This alters the angle of attack throughout the maneuver and turns a benign gentle maneuver into a more aggressive one. The pull-outs generate significant G-loading. At the top of the maneuver the aircraft begins to approach zero g. Figure 4 shows a phugoid with a Mark II tail. Note how the elevator remains unaffected by the maneuver and the angle of attack has only a very slight variation. Note also that angle of attack changes in the opposite sense of the spring trim case.

Before the MKII tail was available from Lancair, 320/360s in Australia were required to modify their small tails to improve longitudinal stability before they were allowed to be flown. One of the required changes was switching from the spring system to a trim tab.

A few small tail Lancairs here in the US have been switched to an electrically driven trim tab. There are a number of advantages besides the stability improvement. Full movement of the stick is not resisted or hindered by the springs in the trim system and hysteresis found in some installations is eliminated completely.

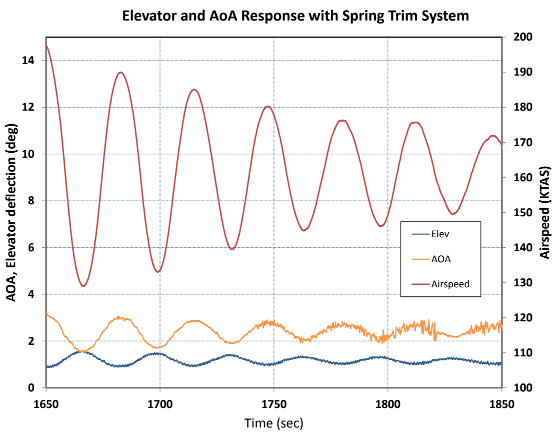

Figure 3, Original Tail, Spring Trim System

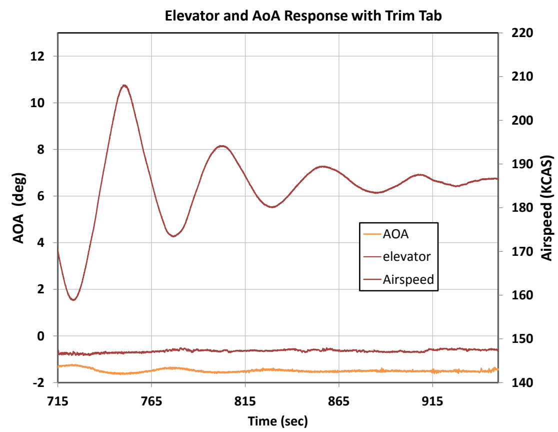

Figure 4, MKII Tail, Trim Tab

The following are a series of photos taken throughout the process of retrofitting a trim tab to a flying L360 with the original small tail.

Before diving into the process of a modifying an elevator, a few words about the elevator hinges is warranted. The original tail uses standard MS hinges. Figure 5 shows the removed hinge on the left backed up to a piece of new hinge material. The wear is visible without even measuring. Wear is a common problem on these hinges in this application, in particular with the outboard hinges. Replacing the stock MS pin with a larger hinge pin will extend the life of the hinge. More information regarding hinge wear and corrective actions can be found in "Hinge Play and Hinge Wear". Even if not switching to a trim tab installation, these hinges should be checked and replaced if necessary.

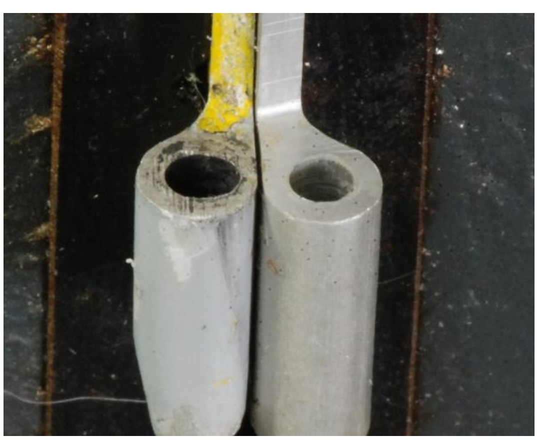

Figure 5, Wear on removed hinge

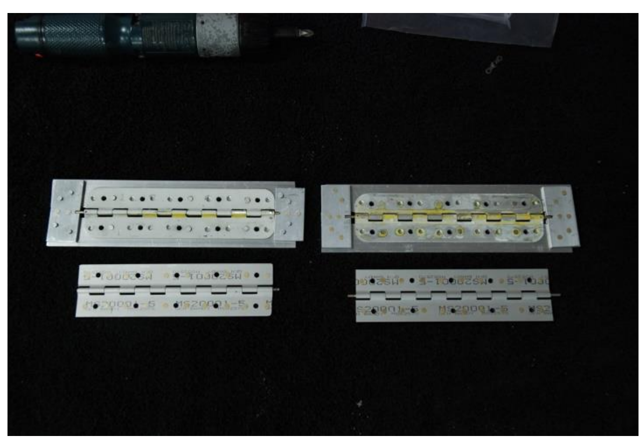

Figure 6, Hinge Jigs and match-drilled Hinges

Figure 5, Hinge wear on this particular outboard hinge was dangerously advanced. Nearly half the wall thickness had been eroded. The aircraft was white, but had been repainted. Note the yellow paint on the hinge. Drill jigs (Figure 6) were made using the original hinges so that the replacement hinges would be an exact copy and all the countersunk screws would line up perfectly. Countersunk screws have no tolerance for being off-center. The replacement hinge must be drilled exactly as the original.

Figure 7, Original Elevator and Hinge

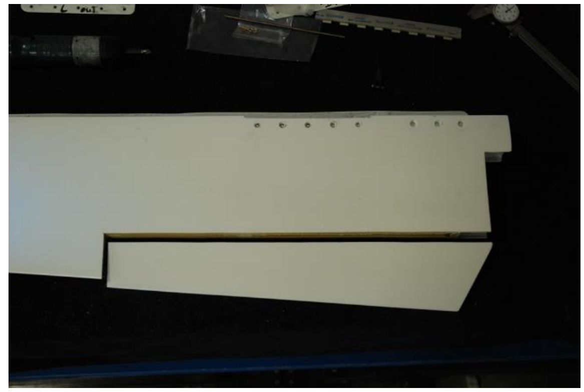

Figure 8, Trim Tab cut form Elevator

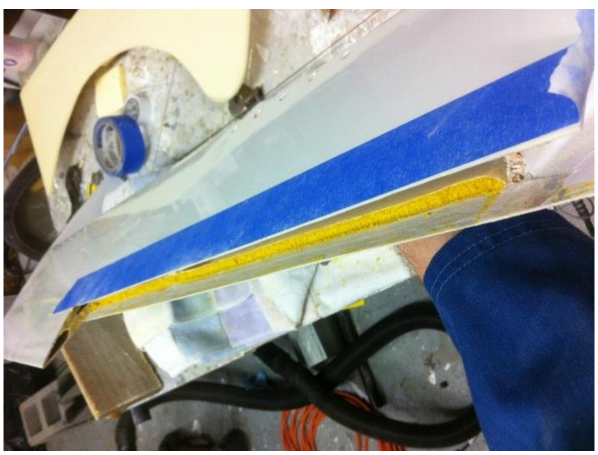

Figure 9, Core material removal

Figure 10, Rear Spar Close-out


Figure 11, Elevator Hinge Mounting Surface Preparation


Figure 12, Tab Hinge Mounting Surface Preparation

Hinges require a flat and straight mounting surface. ¼" aluminum bars were used as backing while a flox release was done with the actual hinge sections.


Figure 13, Hinge Installation


Figure 14, Trim Tab Trial Fit

Both hinge halves were mounted with screws. This approach was the least disruptive to the finish of the parts. Alternatively the hinge sections could have been riveted. This would however require glass work and refinishing of the surfaces.

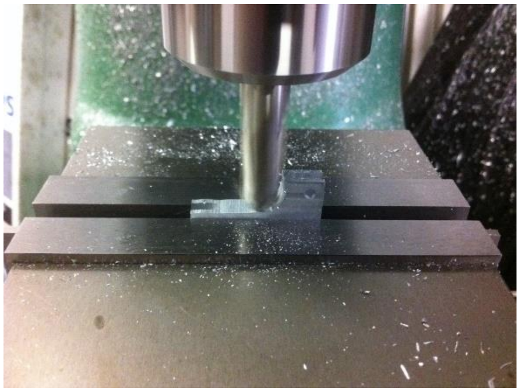

Figure 15, L-Push Rod machining

Figure 16, Actuator and Push Rod

Figure 17, Contouring the Trim Tab

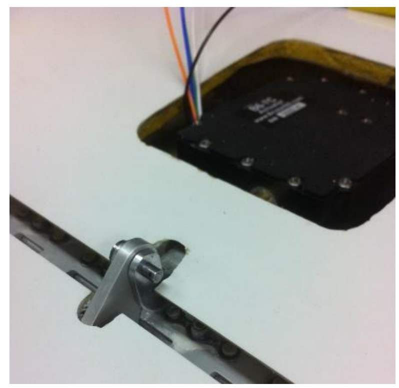

Figure 18, Fit Check

Foam was used to shape the bottom of the tab so that it would provide a gap free movement. The foam received two layers of light weight fiber glass when done. The L-shaped push rod transfers servo motion to the tab without cutting through the lower skin of the elevator.

Figure 19, Lead Counter Weight Removal

Figure 20, Tungsten Bar and Lead

The addition of the trim tab will required additional mass for balancing. The only practical way to achieve this is to remove some of the lead in the balance horn and replace is with Tungsten which has a much higher density. Most balance horns are filled with a combination of lead and epoxy. They typically are not solid lead. The packing density will determine how much material needs to be removed. Tungsten bucking bars are available in a variety of sizes and shapes. The most suitable size was selected to fit the volume. Lead was back-filled as needed. When balance was achieved, all weight was bonded and fiber glassed in to the horn. Micro was used to fill the remaining void.

Figure 21, Micro Finish of Mass Balance Arm