ALTERNATIVES

BEYOND BOOK

Performance kits for laminar flow wings that aren't

BY THOMAS A. HORNE

Ever since the prices of new lightplanes began to skyrocket five years ago, more and more owners have been fixing up their old airplanes instead of trading up to newer models. Many aircraft owners take advantage of modifications that improve performance. Laminar Flow Systems, a small company based in St. Thomas, U.S. Virgin Islands, offers modifications that boost the performance of some of the most popular general aviation airplanes—Piper Cherokees, Arrows, Lances and Senecas.

For a fixed-gear aircraft, the modifications consist of aileron and flap gap seals, flap hinge fairings, a nosewheel strut fairing, main gear strut fairings, main gear wheelpants and a wing kit. The wheelpants and nose gear strut fairings are made of DuPont Kevlar, a lightweight composite material with high strength and resistance to damage. The main gear wheelpants fit over the stock Piper pants. Nosewheel pants are not provided with the kit, so Piper nosewheel pants must be used.

The wing kit includes a template of the wings' upper surfaces and fairings that cover the stock airplane's many exposed rivets and screws. The template permits airframe mechanics to smooth an area extending to 40 percent of the wing chord (about 24 inches aft of the leading edge). By filling minor depressions and lap joints in the wing surface (using polyester microballoons or a flexible epoxy) to conform to the shape of the template, the wing profile can be restored to

original specifications, permitting a more laminar flow of air over the wing.

Retractable-gear airplanes are provided with the same equipment, with the exception of wheel-well fairings, which are substituted for the gear fairings and wheelpants. Aircraft with Frise-type ailerons (the Saratoga, Seneca II and Seneca III) cannot be fitted with aileron gap seals.

"There is nothing remarkable about the technology behind my modifications," says Robin Thomas, Laminar Flow's president. "I merely applied common sense. All I do is give to these aircraft the kind of performance they could have had in the first place, if the factory had built them properly."

Stock versions of the airplanes he modifies generate much drag, robbing them of thrust and lift. The principal culprits are struts and brake assemblies left exposed by stock wheelpants, and turbulent airflow, caused by interference drag and irregularities in the wing surface. The Laminar Flow kits address these shortcomings.

Thomas claims significant increases in rate of climb, cruise speed, range and fuel economy for airplanes using his kits. In two flight tests of Thomas's own Cherokee 140, I observed performance that indicated improvements over the figures in the airplane's operating handbook.

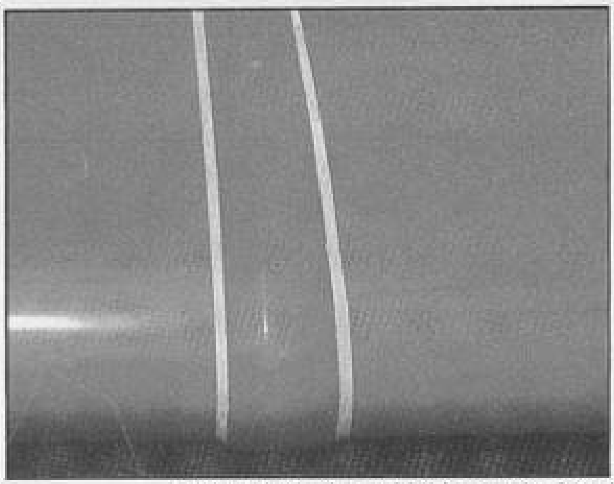
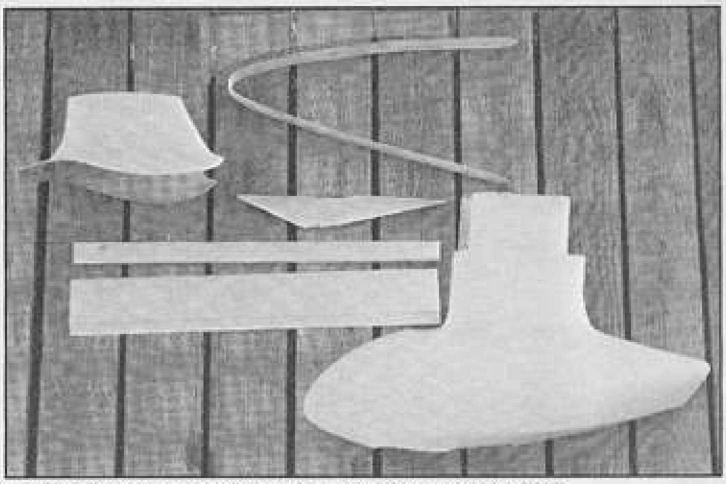
The first test was between Thomas's 140 and an unmodified Cherokee 140 based at St. Thomas's Cyril A. King Airport. Prior to the test, both airplanes' airspeed indicators were calibrated. Then the airplanes were loaded to a roughly comparable weight. The first task was a climb to 6,000 feet. The unmodified Cherokee averaged 410 fpm in the climb, reaching 6,000 feet in 14 minutes 35 seconds. The LFS Cherokee averaged 452 fpm, and took 13 minutes 15 seconds to reach the target altitude. However, the LFS airplane was flown at 87 knots indicated airspeed, not its best rate-of-climb speed of 74 knots.

The next test was of cruise performance. This also was conducted at 6,000 feet, an altitude Thomas prefers because of its predictable temperature (a fairly constant 16°C in that part of the Caribbean) and density altitude (7,800 feet—a figure corresponding to the optimum cruise altitude for most normally aspirated piston airplanes).

The test began with the two airplanes flying in formation at 87 knots. Then full power was applied. Laminar Flow's Cherokee moved ahead, reaching an indicated airspeed of 115 knots. Then the indicated airspeed dropped off to 109 knots. Its true airspeed fluctuated between 122 and 127 knots as the flight proceeded. Thomas remarked that the engine may have lost some power, since it had accumulated more than 2,300 hours of operation.

The unmodified Cherokee turned in a true airspeed of 107 knots—eight knots below the flight manual's published true airspeed of 115 knots for our conditions.

Though we had beaten our competitor by 15 knots, and the handbook by seven knots, Thomas said that the airplane could do better. A post-flight inspection revealed that compression was down on two cylinders and that a

Laminar Flow's wing modifications require that minor depressions and lap joints in the upper wing surface be filled; wing fairing covers fuel tank fastener screws (left). Complete kit for Cherokee 140 (right) includes template, shown at top.

main-gear fairing had split open along a vertical seam at its leading edge. (These fairings are a prototype version with different fasteners from those provided with production kits.) Mechanics suspected stuck piston rings or lead deposits as the cause of the compression problem. This was treated by pouring some diesel oil into the engine's carburetor, then running the engine. This is supposed to clean the combustion chambers of lead and other deposits. This procedure is not recommended by Lycoming. The next compression readings showed that the ailing cylinders had returned to normal. The split fairing was repaired, and preparations were made for a second test—against a 150-hp Grumman AA-5 Traveler.

The Traveler was loaded approximately 300 pounds below its gross weight of 2,200 pounds. Laminar Flow's Cherokee 140 was loaded approximately 200 pounds below its gross weight of 2,150 pounds. In their operating handbooks, both airplanes claim an identical sea-level, standard-condition gross-weight rate of climb—660 fpm. Handbook cruise speed for the Traveler at 75 percent power and 9,000 feet is listed as 122 KTAS.

The LFS Cherokee 140 beat the Traveler in both events.

Time to climb to 6,000 feet was 18 minutes 28 seconds for the Traveler; 12 minutes 57 seconds for the modified Cherokee. Both airplanes were flown at their best rate-of-climb speeds. Rates of climb averaged a mere 324 fpm for the Traveler, but 463 fpm for Thomas's Cherokee. Surface conditions were: field elevation, 11 feet; temperature, 27°C; and density altitude, approximately 1,500 feet. Winds were out of the southeast at 10 mph.

BEYOND BOOK

The differences were equally apparent in cruise. The LFS Cherokee turned in a true airspeed of 130 knots at 6,000 feet—15 knots above the book figure. The Traveler recorded a true airspeed of 115 knots—seven knots below its highest advertised cruise speed.

A third test was run between a 200-hp 1966 Mooney M20E "Super 21" and another Laminar Flow test airplane, a modified PA-28-235 Cherokee B with a 235-hp engine. Although ill-matched in many respects, the competition was revealing. Both airplanes, comparably loaded with respect to their gross weights, climbed to 6,000 feet in the same amount of time—seven minutes 35 seconds, for an average rate of climb of 790 fpm. And at full power and 2,400 rpm, the modified Cherokee 235 matched the Mooney's observed 72-percent-power cruise true airspeed of 142 knots.

This speed was 15 knots below the true airspeed published in the M20E's handbook. LFS's Cherokee 235 beat its own handbook speed by nine knots, a figure that Thomas believes can be improved with further testing.

The Cherokee 140 modifications reduce drag by 25 percent, according to Thomas. He says that the main gear wheelpants (dubbed "fancy pants") are worth an extra 9.5 to 10.4 knots of true airspeed at maximum cruise power settings at 7,500-foot density altitudes. The gap seals, installed alone, add 4.5 to 5.23 knots. The wing kit gives an additional improvement of 10 percent (for the 140, this works out to 11 knots) over book true airspeeds. LFS has been advertising a 22-knot increase over book true airspeeds (from 102 to 123 KTAS) at 12,000 feet. I was not able to substantiate that claim.

Bear in mind that all of Laminar Flow's performance figures are based on weights 175 to 200 pounds below gross weight. This is the loading of the LFS-modified airplanes used in flight testing. It is a loading that Thomas believes to be representative of the majority of flights in light single-engine general-aviation aircraft.

(There were several uncertainties that compromised our flight test results at St. Thomas. Foremost was the condition of the LFS airplane's engine. With 2,300 hours on the tachometer, the engine probably was not running at its full potential, even after the diesel treatment. None of the airplanes had calibrated tachometers, so no one really knew the amount of power being developed. Doubtless there were errors in the airplanes' airspeed indicators beyond those uncovered during calibration. Fuel weights were estimates. And so were payloads.)

Drag reduction affects not only airspeeds, but fuel consumption; therefore range is also affected. The 25-percent reduction means that the airplane requires 25 percent less power to match handbook speeds, while consuming less fuel. It also means that, at similar power settings, modified airplanes will fly faster and farther than those that are unmodified. Thomas says that an LFS-modified 140 cruising at 12,000 feet can average 123-kt true airspeed burning 6.1 gph at 55-percent power, increasing its no-reserve range to 982 nm. The best a standard airplane can do in those conditions is 102 KTAS, with an identical fuel burn and an 808-nm no-reserve range.

Drag reduction can have its drawbacks in airplanes like the 140. With less drag to overcome, fixed-pitch propellers can exceed their redlines at high power settings. This is especially true at lower altitudes and colder temperatures, where an engine develops more power. Pilots flying by inaccurate tachometer readings can contribute to the problem if the gauge indicates an rpm lower than the actual figure.

For the Piper Lance modifications, Thomas claims 35-percent fuel savings compared to book values, and 170-knot 75-percent-power cruise speeds at 8,000 feet (16 knots above book). Thomas flew a Laminar Flow-modified Lance in the 1984 Comparative Aircraft Flight Efficiency (CAFE) race, winning third place with an average speed of 147 KTAS at 58-percent power. Fuel consumption for the 348-nm course was 13.25 miles per gallon. He says that one of his modified Lances, cruising at 155 KTAS, can make the 1,000-nm flight from St. Thomas to Fort Lauderdale with an hour of usable fuel to spare. Lance operating handbooks list a 780-nm range for standard airplanes flown at this speed.

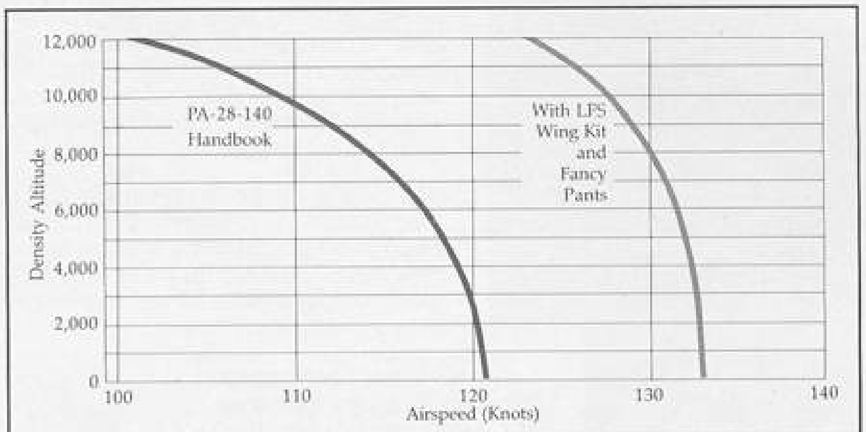
BEYOND BOOK

Performance improvement claims for the Seneca II include a cruise speed increase of 17 knots, fuel savings of 4.5 gph at book 75-percent-power cruise speed, and increases in: twin-engine rate-of-climb (185 fpm); single-engine climb (185 fpm); single-engine ceiling (from 14,500 to 19,500 feet); and range (196 nm).

The price of the full kit runs from $1,922 for most of the fixed-gear Pipers to $3,000 for Piper Senecas without deice boots. Laminar Flow's wing fairing kit is not approved for installation on Senecas with deice boots, so fewer parts are required and the price for these models is much lower.

The chart (below) is a full list of prices, current as of July 1985.

The prices are for kits only. Thomas says that installation times typically are four hours for the gap seals, seven hours for the wheel fairings and between 12 and 30 hours for the complete wing modification. Thomas uses a rough formula of one hour of labor for every $100 of a kit's cost.



LFS performance chart shows improvements over handbook figures (above). Gap between book and modified performance widens with altitude as the aerodynamic benefits make up for losses in horsepower.

PRICE LIST

Aircraft type	Complete wing kit*	Gap seals only	Wheel fairings
PA-28-140, 150, 160, 180, 235 Cherokee (fixed gear)	$1,272	$410	$650
PA-28-151, 161, 181, 236 Cherokee (fixed gear)	$1,362	$500	$650
PA-28R-180, 200 Arrow	$1,681	$410	NA
PA-28R-201 Arrow	$1,771	$545	NA
PA-32-260, 300 Cherokee 6 (fixed gear)	$1,550	$455	$650
PA-32R-300, RT-300, 300T Lance	$2,454	$455	NA
PA-32-301 Saratoga	$1,272	NA	$650
PA-32R-301 Saratoga SP	$1,440	NA	NA
PA-34 Seneca I, II and III	$3,000	NA	NA
PA-34 Senecas with deice boots	$1,755	NA	NA

**Includes wing, flap hinge, and wheel well fairings, and aileron and flap gap seals.—NA; not available.*

At a labor rate of $25 per hour, for example, the installed price of a complete kit for the Cherokee 140 would be approximately $2,450—perhaps more, if your mechanic is inexperienced at smoothing the wing surfaces. That is a lot to pay for a few pieces of aluminum, Kevlar and plastic. But for owners and prospective buyers of aging Pipers, it can make economic sense. A current issue of the *Aircraft Bluebook and Price Digest* indicates that average-condition mid 1960s Cherokee 140s can be had for approximately $7,200. Add the full Laminar Flow treatment and the total cost will still be under $10,000—but the airplane will perform like this year's 180-hp Archer, and save fuel if flown at book 75-percent-power cruise speeds.

Less prohibitive is the cost of gap seal kits. For Cherokees, they run from $280 to $340 less than those offered by Knots2U, a firm based in Wilmette, Illinois, that also specializes in performance modifications for Pipers. Knots2U's president, James Bradshaw, is quick to point out that his kits include all the hardware (cherry-lock rivets, nuts and screws) necessary for installation. Laminar Flow's gap seal kits do not include hardware. Bradshaw also stresses that his company's gap seals have removable parts, which permit easier inspection of aileron hinges and push rods.

Thomas's 140 is being used as a test bed for other Cherokee 140 modifications. He is working towards Supplemental Type Certificates (STCs) for a tuned exhaust system (he says it should be able to push the airplane to 139 KTAS), a gross weight increase to 2,300 pounds for LFS-modified 140s (150 pounds above the standard airplane's gross weight) and a kit that reduces interior noise levels.

Laminar Flow has sold approximately 350 kits, most of them to owners of Senecas. So far, Thomas says, owners are enthusiastic about their new-found performance and confirm his claims. The main gear wheelpant modification received its STC in July 1985, so shipments of these items have just begun. The first to install complete kits will soon know if they can meet Thomas's claims.