—The Case of the Speedy Seneca—

A new aftermarket speed mod gives Piper's dirty old wing a facelift and 15 knots more potency.

The wing of the Piper Seneca is enough to make an aerodynamicist reach for his Sic-Sac. First of all, it's a primitive constant-chord low-aspect-ratio planform, more suited for an economy trainer than a high-performance twin. (That's no coincidence; the basic wing was designed for the Cherokee two decades ago and grafted onto the Seneca to save money.) Secondly, the wing surface is festooned with rivets, screws, brackets, lap joints and other drag-producing aeronautical encrustations. Up close, a Seneca wing looks like a candidate for a Clearasil commercial.

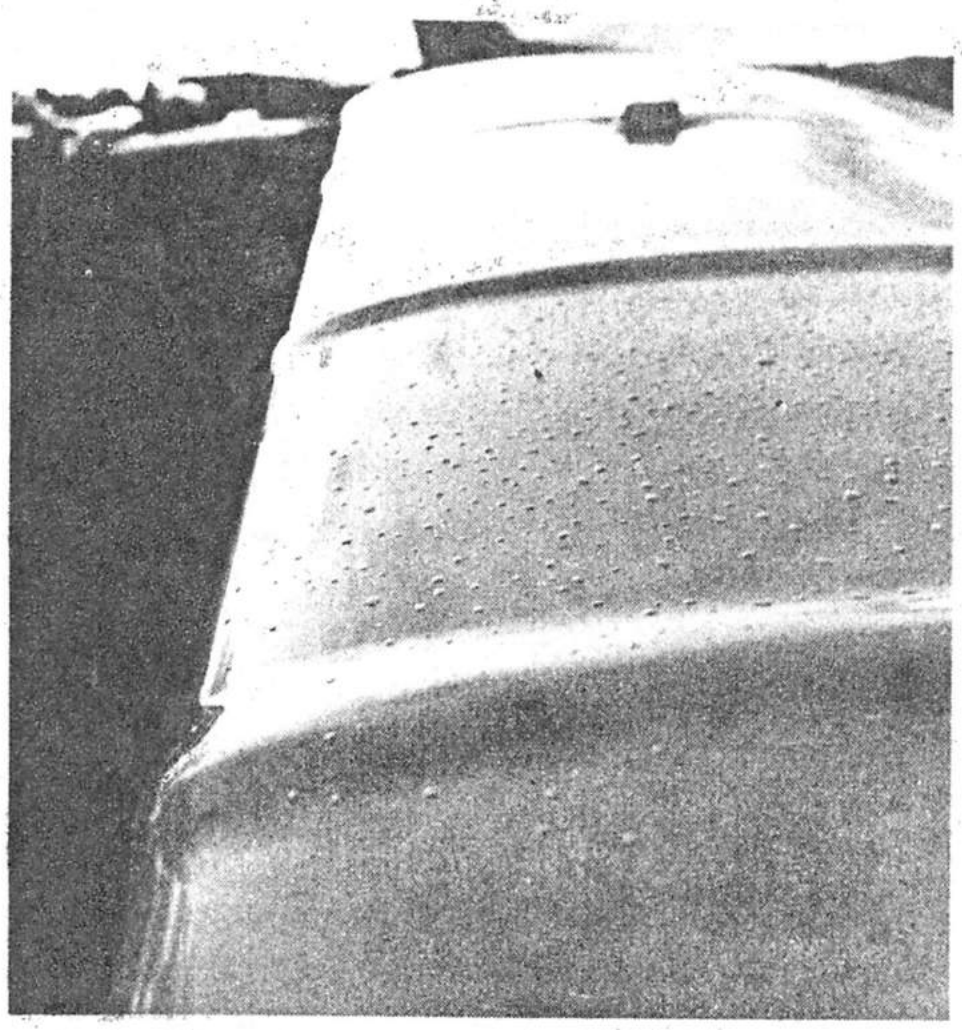
As a result, the original Seneca suffered the humiliation of flying slower than the Partenavia P.68 twin, which used identical engines and had *fixed gear*. And its single-engine service ceiling was a pathetic 3,650 feet, less than even the lowly 150-hp Apache.

Piper "solved" the Seneca's drag problem with more powerful turbocharged engines, renaming it the Seneca II. Cruise and single-engine numbers did improve, but only at the cost of much higher fuel consumption and engine maintenance.

Speed nut Robin Thomas *has been a Cambridge student, spearfisherman, printer, anthropologist, friend of mystics and dictators—and dedicated bush pilot.*

Food for Thought

All of this was running through the mind of a chap named Robin Thomas a couple of years ago as he droned along over the Caribbean Sea in his battered 1973 Seneca. Thomas lived in the Virgin Islands, and made regular charter runs in his Seneca to the island of Grenada, some 500 miles to the south. Sitting there in the cockpit, three hours from home, Thomas asked himself, "Why won't this thing fly any faster than 157 mph?"

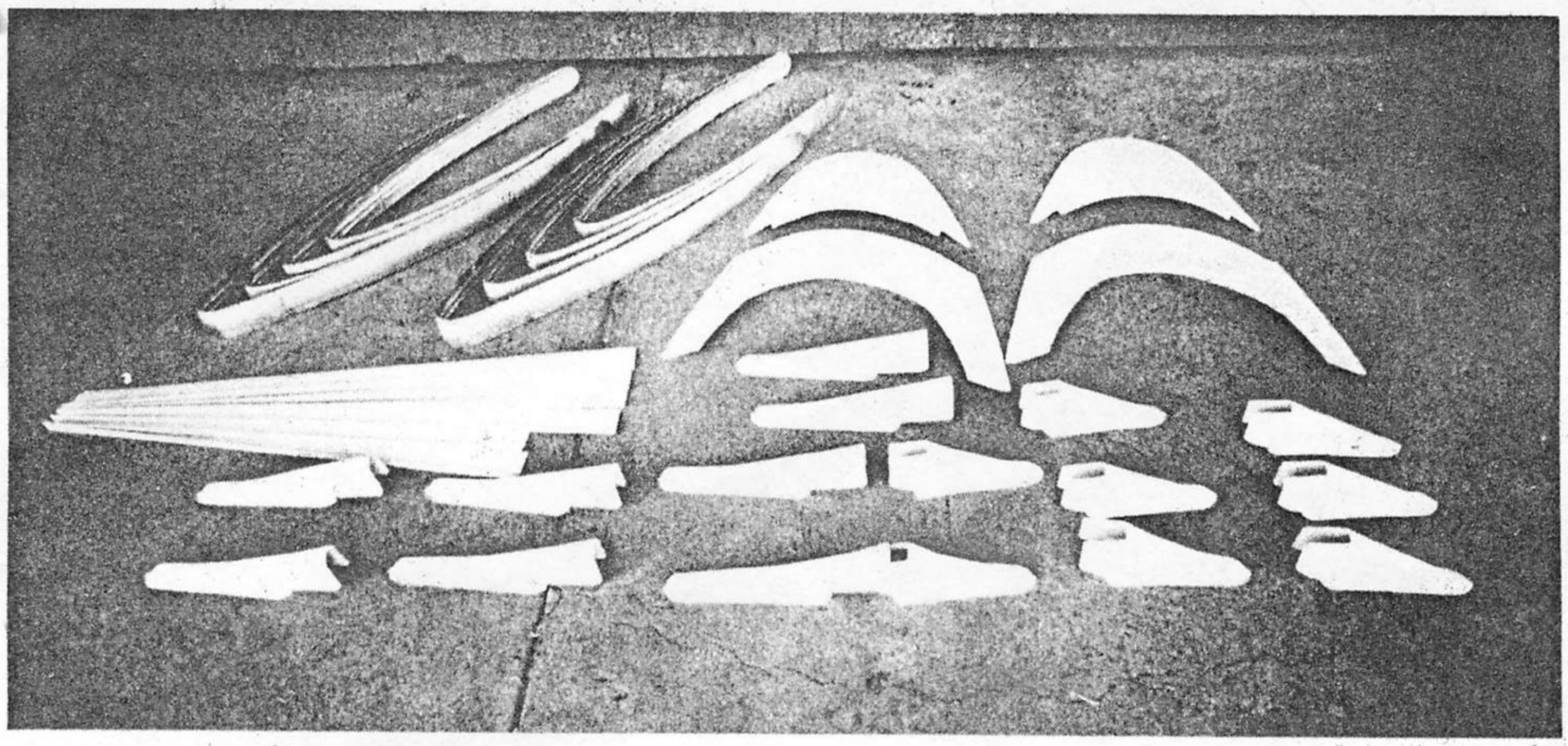


Sculptured lumps on the upper surface *of the Seneca wing are fairings that hide drag-producing rows of exposed screws and rivets.*

Robin Thomas is an interesting character. He was born in Argentina, the son of an itinerant British business executive, and packed off to an English boarding school for most of his childhood. After graduating from Cambridge, he returned "home" to Mexico, where his parents had moved by then, went into the printing business, made a potful of money, and began to wonder what it all meant. At the age of 30, he sold off the business and moved into a grass hut on a remote Mexican beach, surviving by spear-fishing and flying charters in a Lockheed LASA-60B, an obscure Mexican-built utility plane along the lines of a Cessna 206. At various times he has dabbled in medicine, anthropology and the tropical fish business. He was the best sailboat racer in Mexico for years. Through it all, Thomas kept flying, mostly bush work all over Mexico and the Caribbean. Along the way he picked up an A&P license and all the outback skills necessary to keep a plane flying when the nearest factory service center is 1,000 miles away.

Sitting there in his Seneca, Thomas decided he knew very well why it flew 157 mph: that damn wing. So he began fiddling and tinkering, and over the past couple of years has developed a series of modifications that boosted the cruising speed of his Seneca by about 18 mph while dramatically improving single-engine performance.

Thomas knew he had something good. And since the small fortune he had accumulated in the printing business had long since disappeared at the hands of crooked investment counsel-



Here's $2,500 worth of sheet metal: *the Laminar Flow Systems kit. Bondo for leading edge contouring is also included.*

ors, it occurred to him that he might be able to sell his modification kit. Thomas didn't know where to begin getting it certified, so he dropped in on FAA Southern Region headquarters in Atlanta, and asked, "What should I do?" They suggested he call a Designated Engineering Representative—or DER, a sort of free-lance engineer designated by the FAA to do certification work—named Peter Peck. Peck happens to be chief of structural engineering at Piper in Vero Beach. Thomas showed his stuff to Peck, Peck allowed as how it all looked pretty good to him, the paperwork was submitted, an FAA test pilot came down for a day of test-flying, and the Supplemental Type Certificate was issued—all in the space of six weeks.

Big Business

The speed mod business has mushroomed over the past two or three years. First came Bonanza impresario Mike Smith, then Skylane guru Charles Seibel. There are now speed mods for Comanches, Lances and Mooneys. But the mod now offered for the Seneca series by Robin Thomas's company (called Laminar Flow Systems, Box 8557, St. Thomas, USVI 00801; 809-775-5515) may be the most rewarding of the lot in terms of speed gain and fuel savings per dollar invested. At least that's our conclusion after test flights in two different modified Senecas.

The LFS Seneca mod consists of five major components:

• Fairings to cover the four rows of protruding screws and rivets stretching from the leading edge back to the main spar of each wing. On Thomas's prototype aircraft, the fairing joints were smoothed with Bondo (a type of body putty commonly used in aircraft) to give a glassy sculptured look, but the first customer aircraft (a Seneca II) did not get the elaborate Bondo sculpturing. Thomas believes the difference is negligible.

• Flap gap seals. These prevent air from spilling through the gap between the flap and the wing. Control surface seals are a popular and well-proven drag reducer (Smith, Seibel, Knots 2 U and the various Mooney modifiers all employ them), and they usually improve the effectiveness of the surface in the bargain.

• Flap track fairings. The Seneca's flap tracks are very draggy; one piece even "cups" the air—the very antithesis of good aerodynamics. Thomas wraps each of the eight tracks in a smoothly contoured fairing.

• Wheel well fairing. The Seneca, like many "economy" retractables, has dangling gear and no doors to cover the wheels. The front edges of the mainwheels are tucked below the wing's surface, but the trailing edges jut out several inches, disrupting air flow. Thomas adds a fairing behind the protruding wheel that allows smooth airflow under the wing. (Beech did the same thing with its doggy Sierra a few years back and picked up about six mph.)

• Resculpturing of the inboard leading edge. The Seneca wing leading edge inboard and just outboard of the engine nacelles is a jumbled aerodynamic nightmare. The "airfoil" is more like a flat-sided wedge, with great gaps and jogs between skin panels; it's tangible proof that the proverbial barn door will fly with enough power. Thomas fills in the entire inboard leading edge with Bondo and sculpts it with a template to the Seneca's precise airfoil shape. The result is a leading edge of a sailplane-smoothness. Other leading edge junk like the stall warning vane plates and any dings or dents also get smoothed out.

In addition, the boarding step and the front part of the wing walkway are removed.

How Much Improvement?

Thomas claims a speed bonus of 15-20 mph, and we believe the claim is accurate. We base this conclusion on test flights in the prototype aircraft and the first customer-modified airplane. Unfortunately, various factors beyond our control made the flight tests something less than definitive, but we have no doubts that the LFS mod gives major improvements in speed and/or fuel economy and rate of climb.

Flyoff

Our first test flight was a side-by-side flyoff of Thomas's modified prototype and a stock Seneca. Both aircraft were identically and rather slightly loaded—two occupants and less than half fuel. After takeoff from the scenic 4,600-foot runway at St. Thomas, the two aircraft formed up for a climb race from 4,000 feet (the lowest altitude at which the air was smooth) to 8,000 feet. Our reporter rode with Thomas in the modified plane.

We climbed noticeably faster than the standard airplane. (Both used 120-mph cruise-climb speed.) The modified aircraft took 4:56 to climb from 4,000 to 8,000, while the standard aircraft took 6:23. When we leveled at 8,000, the standard airplane was just coming through 7,400 feet. The numbers work out to average rates of climb of 810 and 625 fpm—a 30 percent improvement for the modified airplane.

For the side-by-side speed test, instead of relying on airspeed indicators, we timed the interval the slower plane took to drop behind by its own length, as sighted against a fixed point on the faster plane. Result: about a 10-mph improvement.

The third phase of the test was an engine-out climb comparison—or in this case an engine-out descent comparison. At 8,000 feet, both aircraft throttled back the left engine to idle, without feathering, while maintaining 110 mph. Result: during the next three minutes, the standard airplane lost 1,300 feet, while the modified plane lost only 750 feet.

World's Best Seneca?

The Seneca II or III owner bent on customizing his airplane to the nth degree doesn't have to limit himself to the Laminar Flow Systems aerodynamic cleanup. SGH, Inc. in Auburn, Washington, has developed a three-pronged engine modification that theoretically (we haven't tested it first-hand yet) should give dramatically better engine power, economy, and cooling, particularly at high altitudes. The system, called Turboplus, consists of the following:

- Improved induction and filter system. Rather than sucking hot, low-pressure air from the rear of the engine compartment, an external scoop draws in cold ram air from the slipstream. A more efficient plenum cuts pressure losses on the way to the turbocharger, and a bigger, more efficient air filter allows freer breathing and better filtration. The result is a reduction in inlet air temperature and EGT, and an increase in available manifold pressure at higher altitudes. According to Turboplus, critical altitude is increased about 5,000 feet. This means, for example, that instead of putting out the normal maximum of 55 percent power at 22,000 feet, the engines could develop 75 percent power at that altitude. The result would be an increase in maximum true airspeed, at least 10 knots or so at extreme altitudes.
- An intercooler to drop induction air temperature. SGH says its intercooler can reduce temperatures by up to 100 degrees F. under certain conditions. This allows power to be developed at much lower manifold pressures (about one inch less for each 20-degree temperature drop). Like the induction mod, the intercooler allows more power at high altitudes. Power bonus: about 20 percent, with resultant impressive speed gains. Perhaps more importantly, the intercooler will reduce EGT by the same 100 degrees, allowing more leaning. The Seneca III, for example, is limited to a max EGT of 1525 degrees at 75 percent power, and burns a horrendous 29 gph as a result. An intercooled engine could be leaned more aggressively (at any altitude), with concomitant fuel savings.
- Pressurized magnetoes. A big problem with the Seneca II and III has been their tendency to misfire at high altitudes due to arcing in the magneto and harness. (Arcs occur because the low-pressure air has less insulating property.) It's been a serious problem that makes the airplane virtually useless above 15,000 feet in some cases. The Turboplus mag pressurization kit is designed to eliminate the problem completely.

SGH is also testing a mod that would bring the Seneca II engine up to Seneca III standards (220 hp instead of 200), and allow a 150-pound increase in gross weight. They hope to have it certified shortly.

Price tag for the full-house induction, magneto and intercooler mod is $9,000. We haven't yet tested a Turboplus Seneca II, but hope to soon. And we're just waiting to see what a Seneca II could do fitted with both the Turboplus and Laminar Flow Systems mods. (As a matter of fact, the two companies have been in touch, and may well combine forces on a Super Seneca II demonstrator.) At very high altitudes we might see speeds approaching 230 knots with reduced fuel consumption and good engine cooling. Who said the Seneca was a dog? SGH Inc., 1725 E Street NW, Auburn, Wash. 98002, 206-735-2671.

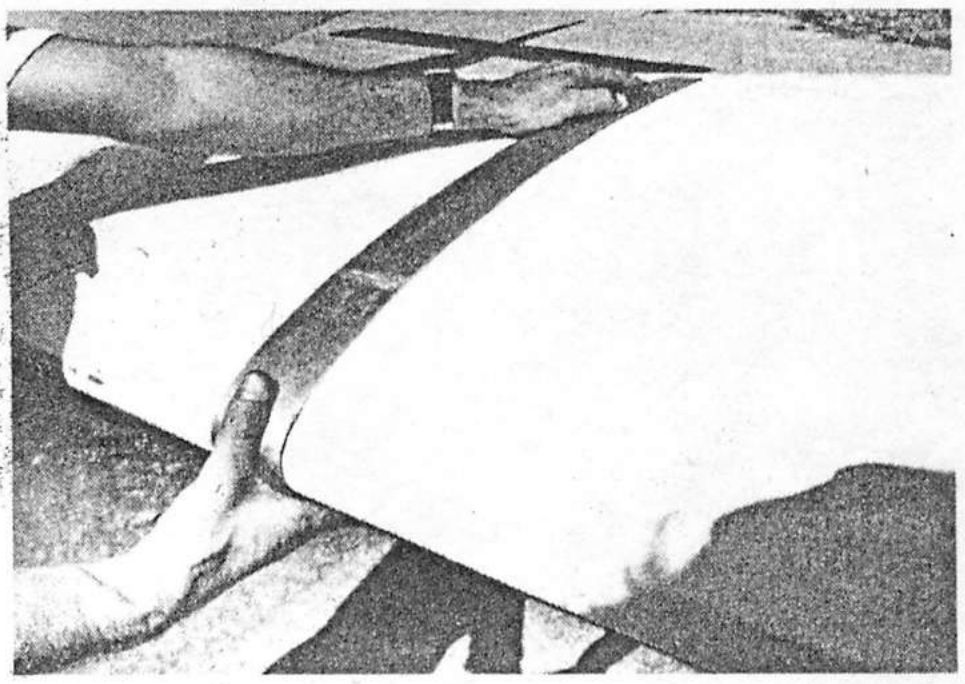
It should be noted that Thomas's Seneca has badly worn-out engines with about 1,600 hours on the tachs. In fact, an inspection just before our flight showed that compression was less than 60 on three out of four cylinders on the left engine, and nearly as bad on the right. During our flight the left engine ran very rough, and had to be operated at full rich mixture. We believe the differences in two-engine performance would have been much larger had the modified aircraft developed normal power. Thomas says he has noticed a five-mph speed loss in the past few months, even though no aerodynamic changes were made. He assumes it is due to engine deterioration as the 1,600-hour TBO time draws near. After the test flight, in fact, Thomas grounded the airplane until both engines can be overhauled.

Seneca II: Before and After

The first customer modification was carried out on a Seneca II earlier this year. We had planned to do a precise before-and-after comparison of the plane's performance. Unfortunately, however, Thomas unwittingly botched the validity of the test results. During the modification process after our initial test run, he made a routine inspection of the engines and cowlings, and found several cooling baffle seals mispositioned. Naturally, he fixed the seals. The result was a dramatic improvement in engine cooling. That was fine for the airplane and its owner—but it threw our test results in doubt because the airplane's cooling drag was presumably increased, now that it was finally getting some cooling. (Most airplanes lose 3-5 mph when the cowl flaps are opened, not so much because of the drag of the doors themselves, but due to the much larger mass of air flowing through the engine.) In terms of drag, fixing the baffle seals was equivalent to opening the cowl flaps. Unfortunately, Thomas initially didn't tell our reporter that he had done this, and didn't realize its significance until after the plane had already returned to its owner.

Although our before-and-after tests were therefore not definitive, the results are worth recounting anyway. The modified airplane, presumably carrying its extra burden of cooling drag, still climbed 15 percent faster to 10,000 feet, with temperatures well down in the green rather than right at red line.

The unmodified airplane ran very hot at cruise, and it was necessary to open the cowl flaps most of the time. The airplane's owner didn't feel good about running more than 65 percent power on that rather hot day. With



Fairings slip over the wing's leading edge. *The complete modification takes about six man-days.*

these limitations, the maximum cruise capability of that particular airplane on that particular day at 10,000 feet was about 162 knots (186 mph). Three days later, with the cooling problem fixed and the speed mods in place, the same plane was able to make 185 knots (212 mph), at a higher power setting with cowl flaps closed.

Another way to look at the performance of the modified airplane is to simply compare it with book figures. (This assumes the airspeed indicator is reasonably accurate, a somewhat shaky assumption in many cases.) From this point of view, the performance of the modified Seneca II was impressive.

At 10,000 feet (outside air temp 10 degrees C.), the aircraft indicated 154 knots at 31 inches and 2400 rpm. This works out to 158 knots calibrated, or 189 knots true at 69 percent power. Book speed under those conditions is 174 knots. Speed bonus: 15 knots.

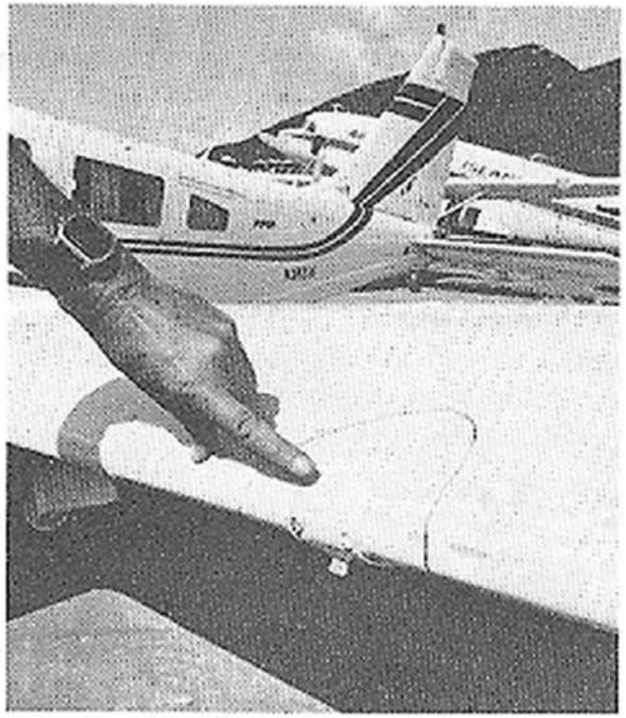
That speed may have been a knot or two higher if we had leaned properly. At standard temperatures, 31x2400 is 75 percent power, and the Seneca book prohibits leaning at 75 percent. So we left it full rich. Later, when we added in the temperature correction, we discovered that we'd been using only 69 percent power, and therefore could have leaned, resulting in slightly more power and speed.

Finally, for one more perspective, we checked with the owner of the Seneca II after a week or two of flying his slicked-up aircraft. He reports about a 10-knot increase in indicated airspeed under his normal flight conditions: about 60 percent power at 2,000 feet. At higher power and altitude, this would increase to about 15 knots true airspeed increase. In addition, his cooling is better.

As far as we're concerned, all the signs point to a solid 15-knot gain with the Laminar Flow Systems Seneca mod.

Single-Engine

We also tried a single-engine test on the Seneca II. In its standard form, the aircraft would just maintain altitude at 10,000 feet with one engine set to approximate zero thrust and the other at cruise power. Under the same conditions, the cleaned-up aircraft was able to climb 220 fpm. To a Seneca pilot with a heavy load over high terrain



The accusing finger of Robin Thomas *points out yet another source of drag on the Seneca wing: the plate that encloses the stall-warning vane. It will be smoothed over.*

was a bit slower, but not enough to justify remarking the airspeed indicator." As for the other flying qualities, Sample comments, "It seemed to fly pretty much the same as the standard Seneca. Vmc was unchanged."

Cost Benefit

The drag reduction provided by the LFS mod can be used in a variety of ways. The benefits can be harvested as rate of climb, speed, economy, engine cooling or more aggressive leaning. Robin Thomas gets absolutely evangelical when he starts to describe all the ways his 15-knot speed bonus can be used. Consider, for example, a

the same job. That's a dollar an hour savings, or $1,800 over the life of the engine.

Price of the LFS kit is $2,500, plus six man-days of labor, for a total of about $4,000. Assuming the maximum available fuel savings of about 4.5 gph (obtained by throttling back to the former 75 percent cruise speed) the mod will pay for itself in gas at the rate of about $9 per hour. Add $1 for engine overhaul time, another $1.50 for reduced maintenance cost (nine percent more distance between 100-hour inspections, don't forget). At a total savings of $11.50 per hour, a Seneca owner will pay off the $4,000 cost of the kit in about 350 hours, or less than two years of normal flying.

That sort of economies should get the attention of commercial Seneca operators in particular.

In fact, by this sort of economic analysis, the LFS Seneca mod is by far the best of any of the other popular speed mods. The initial cost per mph gained is less than any of them, and the payback period is nearly twice as good as the next best mod (and nearly four times better than Mike Smith's gold-plated Smith Speed Conversion).

Field Installation

LFS's Thomas has no desire to get into the installation business. Therefore he plans to simply ship out kits of parts and instructions for installation on the local level. The first batch of kit parts should be ready for shipment by about the time this appears in print with a heavy load over high terrain, that's some difference.

Stall Speeds

Surprisingly, the LFS mod seems to have a noticeable (and positive) effect on stall speed. We hadn't anticipated any changes, and so didn't do a thorough stall evaluation. But the owner of the modified Seneca II reports a noticeable drop in stall speed. "I made the first few approaches at my normal speeds, and the airplane just wouldn't quit flying. The stall horn blows at least five knots slower than it used to. It's definitely better. It'll be a big help for some of the short fields we go into down here."

We also talked to Bob Sample, the FAA test pilot who put the LFS-modified Seneca prototype through its paces for certification. (Sample wasn't concerned with speed increases, of course, only that the modified airplane still met all certification criteria.) According to Sample, "The stall speed

can be used. Consider, for example, a standard Seneca II that can make a given 600-mile trip in four hours, cruising at 168 knots at 65 percent power, burning 20.5 gph. A modified airplane could:

- Fly at 183 knots on 20.5 gph. Savings: 22 minutes, eight gallons.
- Fly at 168 knots on 17.5 gph. Savings: zero minutes, 12 gallons.
- Fly at 191 knots on 23.5 gph. Savings: 28 minutes, zero gallons. An economy nut could throttle back to his former 75 percent speed and reduce fuel consumption by 4.5 gph (nearly 20 percent), while a speed demon could fly 23 knots faster while burning the same fuel for the trip.

Engine overhaul reserve also comes into the picture. A Seneca II engine costs about $9,500 to overhaul, with a TBO of 1,800 hours. Call it $5.25 per hour per engine, $10.50 per hour for the pair. Since the airplane will be roughly nine percent faster, the engines will put in nine percent less time to do

the time this appears in print.

However, Thomas has talked of doing the occasional installation in the Virgin Islands, possibly as part of a vacation package that would allow Seneca owners (and their families, presumably) to loll on the superb beaches of St. Thomas and St. John during the three-day installation period.

Thomas has big plans for the future. He says he'll have basically the same mod (minus the leading-edge recontouring) approved for the Cherokee Six and Lance by the time this appears in print, with the entire PA-28 Cherokee "Hershey bar wing" line to follow shortly. He's also talking about nacelle louvers in Cessna 421s (to cut down on thermal shock and allow rapid descents), automatic devices to spin up wheels before landing and thereby extend tire life, automatic braking systems, etc. No telling what this fellow Thomas will come up with next.

—*Dave Noland*