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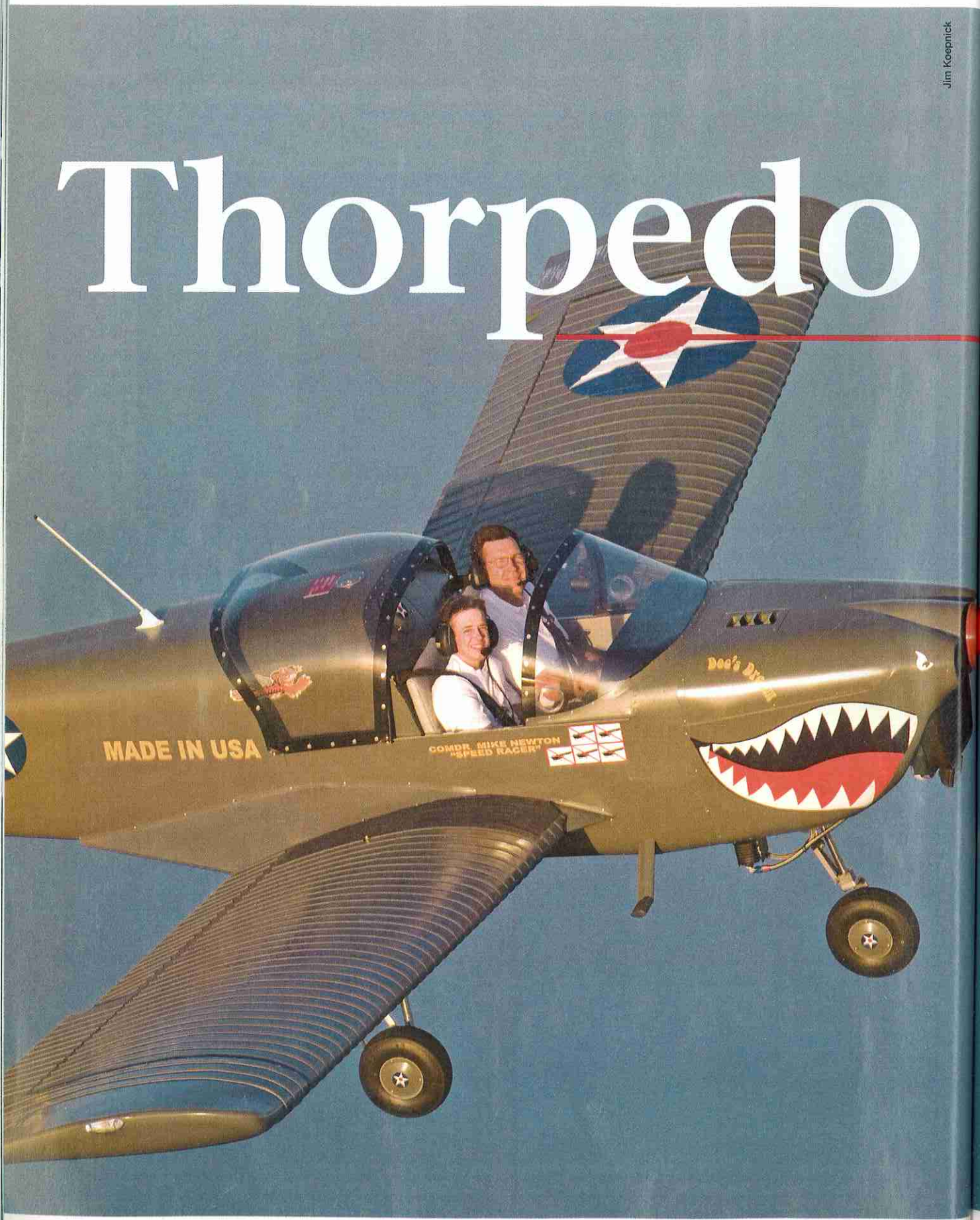
Thorpedo



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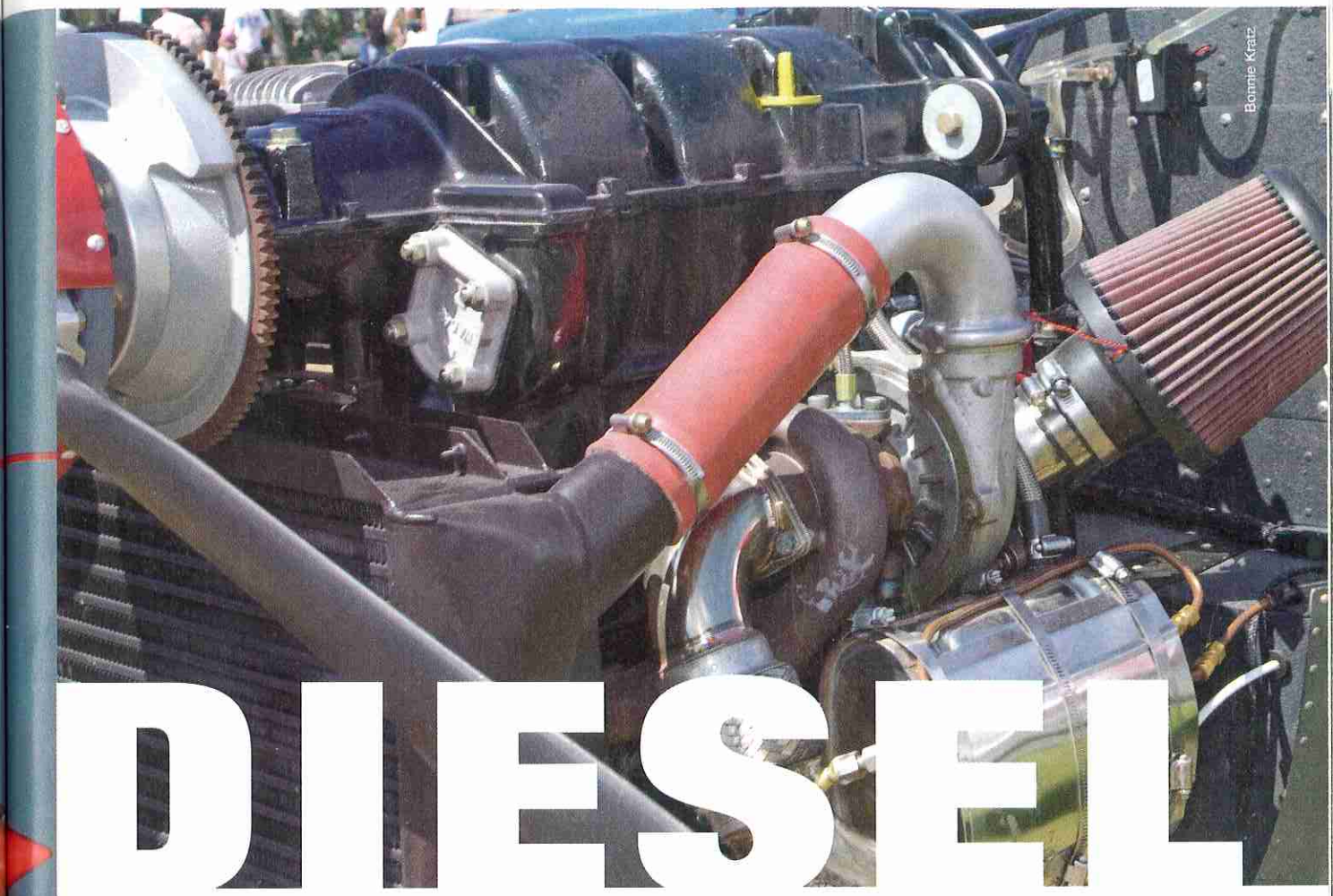


DIESEL

COMING INTO ITS OWN

BY BUDD DAVISSON, EAA 22483

It's hard to believe the design is more than 60 years old.

As you walk around the Thorp T-211, now renamed the T211 Thorpedo, it's so nice-looking (maybe retro to some) that it's even harder to believe the little airplane never caught on. But thanks to IndUS Aviation Inc. of Dallas, Texas, it's beginning to see the light of day again.

Anyone who saw the Thorpedo at Sun 'n Fun 2008 in Lakeland, Florida, found something else hard to believe: Its engine had only three cylinders, all pointed down. There were no spark plugs, but it had two blowers. If you didn't read the sign that said "Powered by WAM Diesel," you would have done some serious head scratching.

The intake air filter and exhaust muffler can be seen here. The production model eliminates the muffler and is quieter. The production model also puts the intercooler, oil cooler inside the cowl, with the radiator hung on the belly.

The WAM diesel is new news, and the Thorpedo is not-so-new news, so let's start at the front of the airplane and gradually work our way around to the newest old FAA-certificated-but-now-light-sport-aircraft airframe around.

The Thorp T-211 was originally powered by a 50-hp Franklin engine. Through the years it has been gradually upgraded; the Thorpedo currently runs either an 85-hp or 120-hp Jabiru, and now the WAM-120 two-stroke diesel is a ready alternative. The diesel engine boasts 20 percent better fuel consumption, but more importantly, it's burning Jet A or diesel. Also, being a diesel, it does away with such pesky things as magnetos.

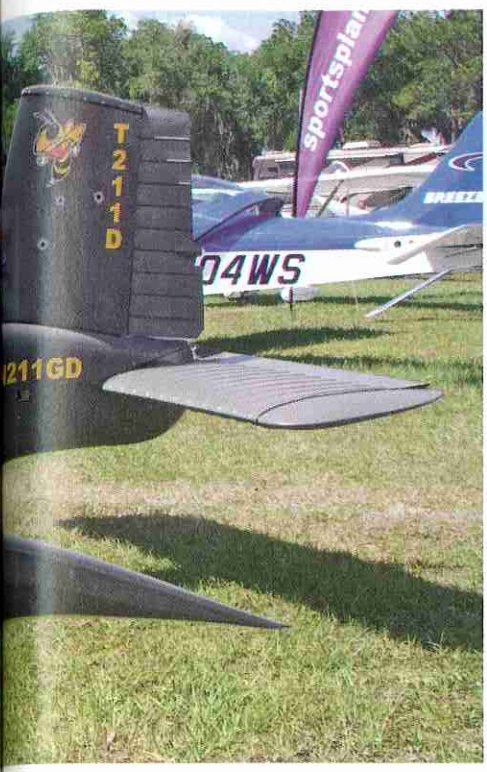
The WAM engine isn't an adapted or redesigned anything. It's a clean-sheet-of-paper design that began in the late 1990s. One of the factors that sets it apart from what are usually automotive conversions is that this engine was designed from the beginning to be an aero engine. Road use was never contemplated. The crank, incidentally, is machined from billet.

A two-cylinder version first flew in England in a J-3 Cub. In 1999, the three-cylinder version sprouted wings in a Europa, which served as its test bed for most of the early flight hours. The original engineering principals applied their experience in race car development and engineering when designing the engine and getting it ready for production. So, although it was an airplane engine, they viewed it as just another new engine in which they would use the latest technology rather than basing it on tradition.

When I saw the uncowled diesel Thorpedo at Sun 'n Fun 2008, I was immediately struck by a barn door radiator up front under the spinner. However, that was a prototype installation aimed at expediting flight testing and is not a permanent disfigurement. The engine cowling is in the process of being updated for better aerodynamics, but studying it in its current elemental form is educational because everything is right out where you can see it, more or less.

On the pilot's side of the engine, you see one of the more diminutive turbochargers to be seen outside of a nitro-boosted, laying-on-the-ground, hopped-up Honda. If you look carefully, you'll see coolant lines coming off the output side of the turbo that appear to go to the radiator. Closer inspection shows that what appears to be a single radiator is actually two: an intercooler radiator covers the front like a transmission cooler on a car. One of the modifications under development is a new radiator/intercooler configuration that puts the intercoolers up inside the stock Jabiru cowling but hangs the main radiator back under the fuselage, like a P-51 Mustang. If IndUS uses the same expansion plenum theory Lee Atwood and Edgar Schmued used on the Mustang, the outflow air may generate enough thrust to offset most of the installation's drag.

This is another John Thorp design parameter: make it fun and make it easy.



Bonnie Kratz

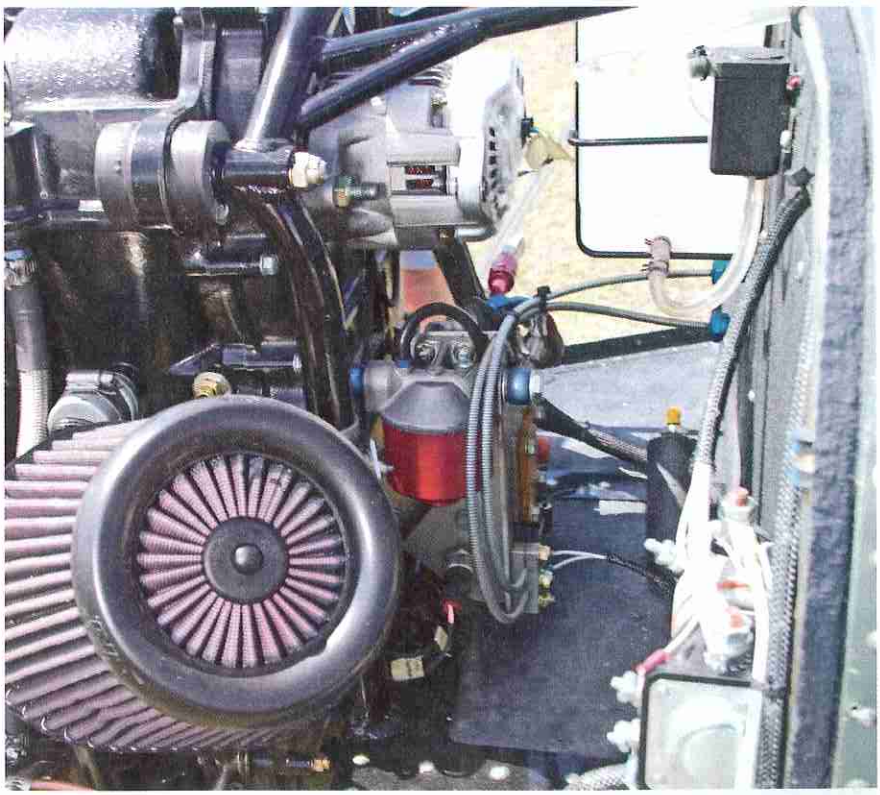
Bonnie Kratz

The right side of the engine, showing from left to right, the smoke oil tank, coolant reservoir, the oil cooler (which is low, front and center in the production model), and the radiator stacked behind the intercooler. The intercooler is a split system - left and right - tucked completely inside the cowl on the production model.

The turbo-boosted air flows around the front of the engine into an internal Roots blower on the opposite side, which is a positive-displacement, two-rotor, three-lobe supercharger that is there to stabilize and guarantee airflow more than anything else. It provides only minimal boost. Being a two-stroke diesel, rather than a four-stroke, the engine needs some boost during the starting cycle, and it wouldn't get that from the turbocharger (no exhaust, no turbo-boost). Also, should the turbocharger die (an unlikely event), the internal blower can keep the engine running and get you home.

The engine is direct drive, and the high torque values associated with diesels allow it to spin a larger, coarser 72-inch diameter propeller than would be expected for an 1800 cc (113 cubic inches) at 2750 rpm.

Rather than setting up a high-overhead production facility, the WAM team developed a series of specialized vendors and outsourced all of the major components, reducing its in-house work primarily to assembly and test running.



Bonnie Kratz

The motor mount spreads the loads to the lower firewall shelf; an integral low pressure lift pump supplies fuel via an engine-mounted fuel filter to a high pressure, engine oil lubricated injection pump, with a return circuit to tank.

The production Thorpedo Diesel will include a Data Logger instrument that records and provides manifold pressure and percent power.

By June of this year, the three test aircraft in the United Kingdom had accumulated 800, 1,200, and 1,250 hours of in-aircraft test time, and 25 engines have been delivered, with 15 already in the air in a variety of airframes, including the Thorpedo. The Thorp/WAM combination has about four years and more than 400 flying hours on it.

WAM began the project with four specific goals in mind, and they appear to have met them all:

- Develop a 100- to 120-hp engine that burns turbine fuel (kerosene/diesel) with the same weight as an O-200 Continental (270 pounds including the cooling system).
- Achieve better than average specifics: lower fuel and oil consumption and more power, torque, and altitude capability than engines of similar horsepower.
- Exceed all airworthiness test standards by a wide margin, including Joint Airworthiness Resolution (JAR) 22H, light-sport aircraft (LSA).
- Achieve a time between overhauls of 2,000 hours, which is now being accumulated in-flight, although LSA test standards have already been met.

Availability? Yes, it has been available for some time on a single unit basis. A U.S. manufacturer that needs larger numbers would have to contact IndUS, which functions as WAM's marketing arm in this country. Inasmuch as IndUS can easily demonstrate both the new engine and its new-old airplane at the same time, its choice as a marketing outlet for the WAM diesel seemed like a natural fit. Especially since the Thorpedo is beginning to be seen in increasing numbers.

THORP PROGRESSION

Growth of the Thorp/Thorpedo has been a long time coming. In fact, John Thorp started laying down its original lines as World War II was drawing to a close. He was working for a subsidiary of Lockheed at the time as a preliminary design specialist and, always interested in entry-level aircraft, he designed an inexpensive, easy-to-fly airplane that would satisfy the expected needs of the flood of pilots returning from the war. During the final years of the war he designed—and built—a simple airplane named the Air Trooper (Model 33) that was supposed to function as an aerial motorcycle that hundreds of soldiers would use to fly over enemy lines to regroup behind. To prove the viability of the concept (it had already been flown by all the top Lockheed test

John Thorp working on a T-18. (EAA Archives photo.)

pilots including the famous Tony Levier and "Fish" Salmon), an Army private was given an hour of ground instruction, strapped into the airplane, and sent on his way. He flew the airplane around and completed an uneventful flight—his first time in an airplane and his first solo flight. Later dubbed the Little Dipper, the airplane featured Thorp's innate ability to design structures that were light, uncomplicated, and easy to produce.

As the war ended and two-place trainers were being designed and built by many, Thorp designed what he called the T-11, and then T-211 Sky Skooter. It appeared to be the ideal two-place trainer/commuter airplane. If you stare at the Sky Skooter long enough, you'll realize something looks familiar. One of Thorp's later assignments was to do the preliminary design for what became the Piper Cherokee. Both airplanes feature similar lines and the now-familiar all-moving stabilator concept, which Thorp patented.

The airplane is a study in reducing parts and eliminating labor. The smaller the number of parts in any assembly—airplane or otherwise—the less the manufacturing cost. Some of the ways in which Thorp did that included the stabilator. By combining the horizontal stabilator with the elevator, a huge number of parts, such as duplicate spars,

watch the video

www.eaa.org/video/eaa.html

A walkaround tour of the Thorpedo Diesel

hinges, and intermediate ribs, were eliminated, although the resulting unit required exacting design and manufacturing standards.

The wings have only two internal ribs, plus root and tip ribs, courtesy of the external corrugations formed into the wing skins. This allowed the skin to be thinner and the corrugations to act as stiffeners, eliminating some of the ribs. In effect, it has an exoskeleton.

Then, to simplify tooling and manufacturing, Thorp developed a concept known as "matched hole tooling." This was an ingenious concept in which a pattern strip was used as a drill guide for two matching surfaces, for example wing skin and ribs, so they could be drilled independently of one another, and the holes were guaranteed to match so the assembly would be true. This meant the units didn't need a heavy jig to hold them in line because, once they were fastened together with Clecos, they were already square. It's more complicated than it sounds, but not much.

Around 1946 and '47, Thorp put together some financiers and production people and had the airplane Civil Aeronautics Administration (pre-FAA) certificated, tooled up, and ready for production when the "great aviation bust" happened. The predictions of thousands of returning military pilots wanting an airplane in every garage proved to be grossly wrong. Many little airplane companies went belly up during that period of time.

Flash ahead to the mid-1960s. John Thorp is still designing and building entry-level airplanes. In 1962 EAA had a design contest for the best roadable airplane (one that could be pulled home rather than hangared), and EAA picked Bowers' Fly Baby. Thorp started with that concept and designed the T-18, which originally had an open cockpit and used a 125-hp O-290G Lycoming ground power unit engine. The wing could be dropped out of the bottom of the fuselage in a single piece and racked up on top of the airplane for towing, although few, if any, were actually built in that configuration. It did, however, go on to be one of the most popular high-performance homebuilts of the '60s through the '80s and is still highly regarded.

As the EAA movement gained strength in the mid '60s and small airplanes became more respectable, another group resurrected the Sky Skooter, John Thorp and all. My first job out of college was working for Tubular Products via John Thorp whom I knew because I had talked my senior aero-design class professor into using the T-18 as our stress-analysis project. I was building one for myself in the engineering lab at the same time.

Tubular Products produced approximately 100 sets of plane parts but only a handful of wing skins. It's unclear how many airplanes were actually assembled from those parts, but it was no more than a few before the company shut down. That was 1965.

The parts and the tooling shuffled through more hopeful owners' hands before surfacing again 25 years later in Phoenix with the Star of Phoenix. The parts then moved through several more owners, including Thorp Aero of Kentucky, headed up by Cliff Rock. Thorp Aero amended the type certificate and acquired a production certificate. It produced about a half-dozen aircraft, most of which were exported due to the legal environment at the time. Eventually Dr. Ram Pattisapu and his company, IndUS Aviation of Dallas, Texas, bought the type certificate, the tooling, and many of the original parts made in Los Angeles.

That was in 2002, and Pattisapu, originally from India, began focusing on bringing aviation manufacturing and a training aircraft to India and emerging world markets. At the time the LSA concept was in its infancy, but IndUS was quick to recognize the potential of the Sky Skooter in that market. Everything about it fit, plus it had the advantage of having been certificated, so the same airframe could be used in both certificated and uncertificated markets. This was/is an airframe that the Civil Aeronautics Administration had tested and found fit for certificated consumption, and that is a huge sales point. IndUS didn't have to worry about LSA self-certification because it possessed the type certificate.


Jim Koepnick

IndUS is based in Dallas with a satellite facility in Bangalore, India. In both locations it has aircraft showrooms and flight facilities. In addition, it works with an Indian aerospace manufacturer that takes the raw material supplied by IndUS, processes the raw materials, and completes some subassemblies of the airplane, which are then shipped back to Dallas for completion and final assembly. Because it's a certificated airframe, all materials and procedures are the same as those that would be used on any other certificated airplane, LSA or not.

FUN, EASY, AND MISERLY

The LSA category offered IndUS a golden opportunity to improve the airplane forward of the firewall. Since it is producing it as an LSA, not in the FAA's normal category, IndUS isn't required to use the original Continental O-200, which was heavy. So it offered the airplane with 85-hp (four-cylinder) and 120-hp (six-cylinder) Jabiru engines. This saves nearly 100 pounds over the Continental and puts the basic empty weight of the 120-hp airplane at 665 pounds, which is incredibly light. Its wing loading is significantly lower than a Cessna 172 at 11 pounds per square foot. Its power loading of 10.6 pounds/horsepower is also significantly lower, which results in greatly improved performance. Having flown the airplane with the smaller engines, I can state that it is a welcome change. And using the Cessna 172 as a point of comparison, the cockpit is a half-inch wider, plus it can be flown with the canopy open.

Incidentally, John had an "issue" about system friction and handling, and that's one of the Thorpedo's real strong points. Even on my first takeoff in the airplane 40 years ago, I loved the way the controls felt. They are light and quick without being overly so, and the airplane can be taken off and landed by virtually anyone at any skill level. This is another John Thorp design parameter: make it fun and make it easy. It's miserly on fuel, burning about 4 to 4.5 gallons per hour even with 120 hp—and that's at 110 mph (or more).

So here we are 63 years after the little Thorp made its first flight and it's still trying to earn its spurs. It has a better shot this time than at any time in the past because of the LSA category and the worldwide need for a small trainer that burns readily available fuel, diesel or Jet A. Maybe its time has finally come.

Budd Davisson is an aeronautical engineer who has logged more than 4,000 hours of dual-given in his Pitts, flown 300 different types, and published four books and more than 2,500 articles. He is also the editor-in-chief of Flight Journal *magazine. Visit him on* www.AirBum.com.

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