SEEING DOUBLE

What makes up a so-called clone engine, and why would you want one?

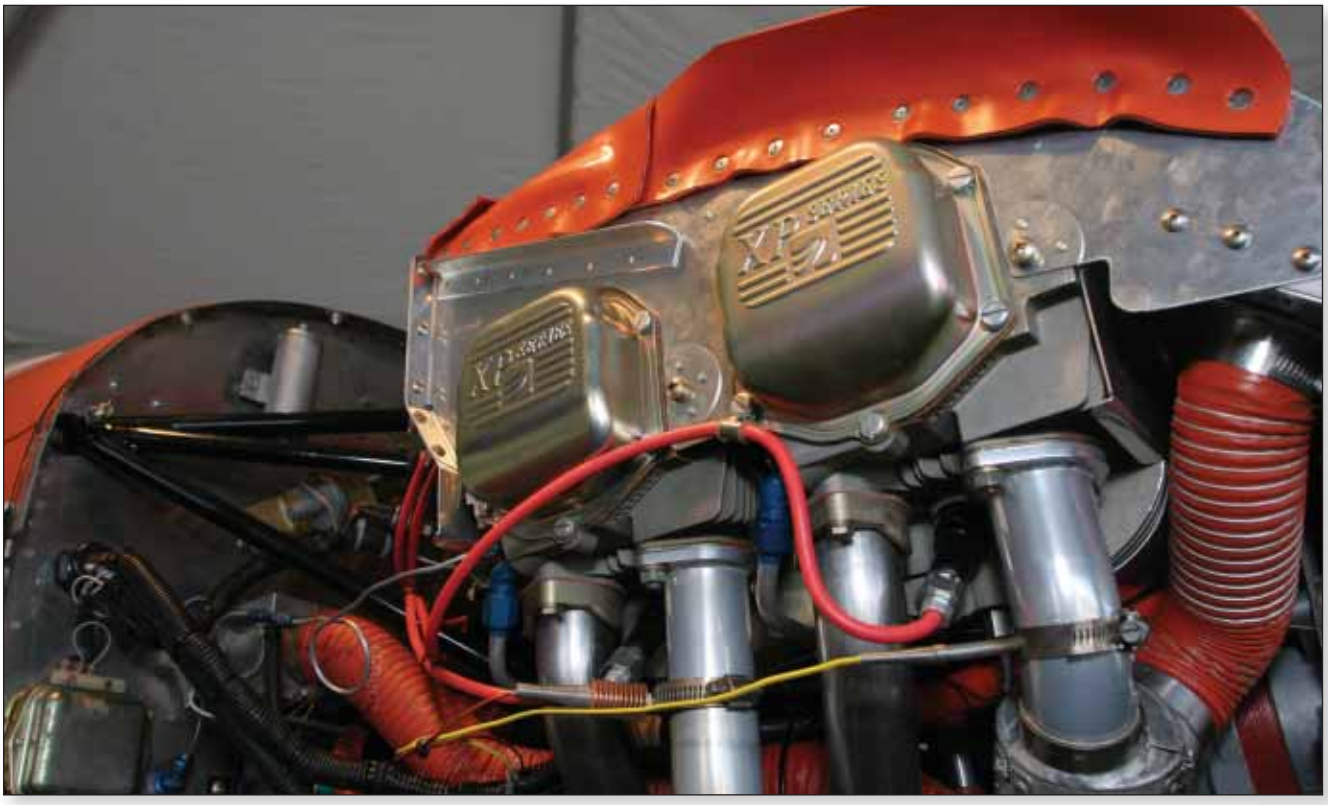
BY MARC COOK

Competition in aviation is as healthy as anywhere else. When two or more companies duke it out for your powerplant dollar, there's a strong possibility that you'll benefit directly. Sometimes you simply get more engine for the dollar—that was the original reason for the rise in aftermarket engines. But now the industry is hopping, with Superior Air Parts and Engine Components Incorporated (ECI) aggressively marketing engines built to the same basic design as a Lycoming O-360 engine but in fact carrying few if any actual Lycoming parts. In addition, Teledyne Mattituck Services has several versions of the Experimental-only O-360 called the TMX-360, which is a specially built version of the ECI engine.

First, though, a bit of history on the industry. Twenty years ago, most homebuilders found their engines in the boneyard or through the common used-engine channels—typically engines that had been in parted-out airplanes. Then the builder would either perform an overhaul himself or have the engine overhauled by a reputable shop. (The unlucky had them done by disreputable shops.)

Slowly the industry began to change. Some engines, the 180-hp Lycoming O-360 in particular, were becoming harder to find in good condition. This was a popular engine in airboats, for example. It was standard practice to send the various pieces out for overhaul—the cylinders to a dedicated cylinder repair station, the crankshaft to a crank specialist, and so on. Putting a brand-new engine on a homebuilt was an option not often considered because of the extraordinarily high prices of new engines.

Eventually, however, companies such as ECI and Superior began making more of their own new parts in addition to offering factory-built (or -sourced) parts and overhauling existing components. With the replacement cylinder business booming, it became the next logical thing to produce whole engines. Work commenced at ECI and Superior to develop individual product and test it for PMA (Parts Manufacturing Authority) approval that, in essence, states that the replacement parts perform the same function as the original-equipment items.



Photos: Marc Cook, Courtesy Mattituck

The result of this considerable effort is what you see today: Complete, all-new engines ready to bolt onto your project at competitive prices. Indeed, the spread from high to low for similarly configured engines is far less than the sales tax on the purchase.

How Different Are They?

The new engines available today are, in the big picture of internal-combustion design, so close to the original Lycoming O-360 that the term *clone*, now considered slightly derogatory, was at one point very apt. However, while the critical dimensions are the same, there are myriad variations in the specific components used and, in many cases, parts are used in the clones that benefit from advanced technology. Let's take a walk through the Superior XP-360 engine (we'll cover the ECI Titan Kit engine next) to see what is different compared to a standard Lycoming.

Superior's engine employs proprietary Millennium cylinders. Superior offers both standard-cast versions of these cylinders as well as investment-cast versions at extra cost. For the optional cylinders, the head is cast using what's called a lost-wax system, which results, so says Superior, in a smoother casting with fewer voids and less variation in material thickness. While designing the cylinder, Superior took the opportunity to change the thickness of certain failure-prone areas of the assembly, particularly in the area of the exhaust port and sparkplug hole. Superior also subtly changed the port shapes to improve airflow and combustion efficiency. These useful improvements are part of both the standard-cast and the investment-cast versions.

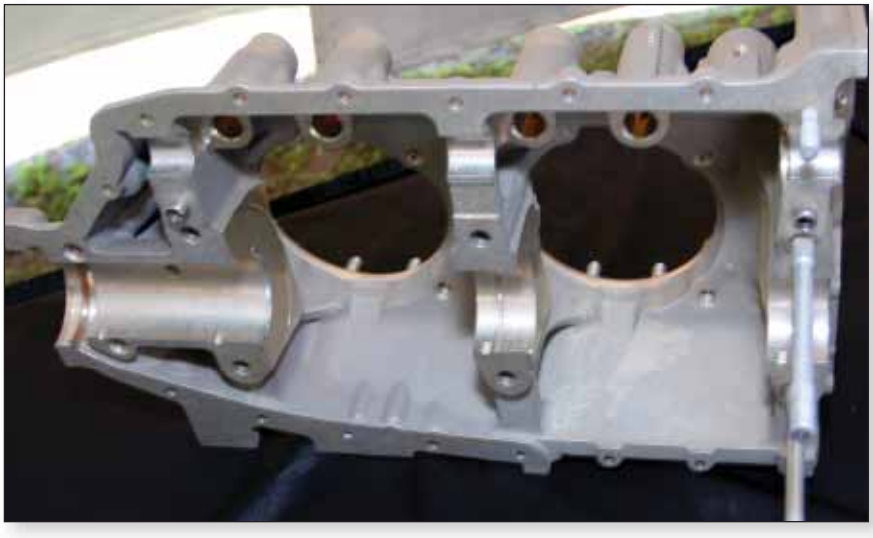
Further down, the XP-360 sports its own PMA-approved pistons and rings. Superior also is offering three versions of the O-360 (plus another group with fuel injection rather than a carburetor) that differ strictly by compression ratio. The standard XP-360 makes 180 hp (at 2700 rpm) with an 8.5:1 compression ratio. A slightly derated 170-hp version is available with a 7.2:1 compression ratio. Both of these engines can be run on alcohol-free autogas. A third iteration uses 9.0:1 pistons and makes 185 hp, but must be run on 100LL avgas. The low-compression version is $100 more than the base engine; the high-comp iteration will set you back $400 more.

Big Bottom (End)

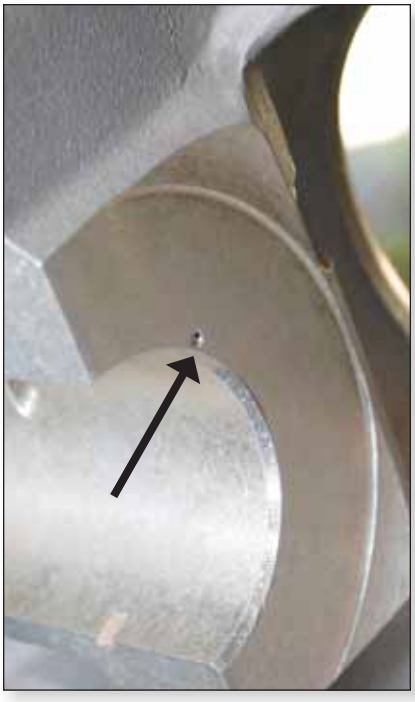
Superior created its own connecting rods for the XP-360—they, too, are PMA approved—that feature tongue-and-groove mating surfaces at the big end to improve rigidity. They grasp a balanced, VAR (vacuum arc remelt) crankshaft that's been balanced to 2 grams. Moreover, the inner diameter of the front of the crank has a special corrosion-blocking surface treatment. This is a great feature for builders intending to use the engine with a fixed-pitch prop, because in that configuration there's little to no oil flow through the nose of the crank, and sludge can develop there.

Oil's Well

This crankshaft fits into wholly new, fine-cast cases developed by Superior. They have a few tricks to share as well. For one, the material between the cylinder pairs on each side is thicker to reduce the chance of cracking. Also, the oiling system for the cam journals has been split, with inlets on both sides of the case near the back. The traditional layout has oil going in one side, pushing forward, and then returning down the opposite side of the engine. This gallery provides lubrication for the cam journals and lifter bodies. Superior says this system maintains even oil pressure across all the journals. And these aren't your typical lifters, either. Superior offers a version of the XP-360 called the Plus that employs roller cam followers and a special cam with an updated grind for improved performance. (Lycoming announced last year that it was rapidly developing roller lifters and it's expected that they will be phased in during the last half of 2005 for certified engines.)



A case in point: Superior's cases are designed to be compatible with basic Lycoming components but offer several improvements. For example, the webbing between the adjacent cylinders is thicker than on a stardard Lycoming part. Mounting bosses for oil-squirt jets aimed at the pistons are standard.



Superior's XP-360 engine uses pressurized thrust-face lubrication. Oil is delivered to the face through the small passage indicated by the arrow. This technique ensures that the face of the crankshaft will have sufficient lubrication.

One other area that Superior addresses is thrust-face lubrication. The forward flank of the crankshaft where it meets the cases—this is the part of the engine that carries propeller thrust loads. Standard Lycoming practice is to allow oil being splashed around in the case (and some that comes down from the cam journals overhead) to lubricate this surface. Superior taps a small hole in the face that leads back to an oil gallery, thereby forcing oil into the gap. In addition, Superior's cases include provision for small jets that spray oil at the bottom of the pistons. Finally, when you plump for an XP-360 engine, you'll have the option of seeing it built (a $500 extra charge) or helping ($1000); see our story "Monster in a Box," April 2005 KITPLANES®.

There are several options available on the XP-360 engine, including various ignition and induction systems. Worth noting is Superior's lightweight sump, which uses a molded polymer—much like the systems used in many modern automobiles—to help separate the induction tubes from the oil supply, which results in a cooler, denser intake charge. The lightweight sump is available in forward- and aft-facing configurations on fuel-injected models, but not for the carbureted versions. The conventional-looking sump for the carbureted models in fact hides a neat trick. In the standard Lycoming, the carburetor tube comes straight up to the divider, where the fuel and air head off to each of the four cylinders. In the Superior version, the integrated intake system has rounded corners where the cross tubes meet the upright and a small hump in the top center of the plenum to help the fuel/air get on its way.

Prices for Superior's XP-360 engines vary by specification, ranging from $20,500 (fixed-pitch, carbureted) to $22,400 (constant-speed, injected). The Plus version of these engines—with a three-year warranty—run from $23,650 to $25,550.

Titanic Fight

ECI was not about to stand around and let Superior have all the fun. However, it is approaching the aftermarket engine from a slightly different perspective. Rather than build the entire engine for you, ECI sells the components for a kit to one of several

engine shops around the county. You don't buy a whole Titan engine directly from ECI, but instead from one of the approved shops. (Superior sells to engine shops, too, with its SL-360 kit, but says that most customers order directly from the company.) This tactic has allowed a lot of smaller shops the opportunity to create truly custom engines from the basic Titan kit. Final prices are set by the assembling shops but are competitive with the other aftermarket powerplants.

The Titan kit engine starts with PMA'd wide-deck cases—available in conical or Dynfocal #1 styles—that

ECI's Titan kit engine is a collection of the company's parts that were developed in house. ECI does not sell whole engines directly to the customer, but relies upon a handful of approved engine shops to assemble the parts.

Inside the IO-390

New aircraft engines don't come along very often, so it's something to celebrate that Lycoming has developed a new member of the family: the IO-390. We hear you skeptics at the back of the class muttering, "Heck, that's just an IO-360 with a larger bore, What's the big deal?"

Best, perhaps, to ask the man who knows something about it. Monty Barrett, of Barrett Precision Engines, is the sole distributor for the new engine.

"It is a very smooth engine because we ask for it to be counterweighted. The engine generates fourth, sixth and eighth order shaking, but the balance weights really help. We get the engine disassembled. We take inventory and then balance the rotating components. Then we assemble the engine. We really don't modify it."

In virtually all respects this engine is a stone-stock Lycoming design. "I don't know what Lycoming changed as far as ventors or processes," Barrett says, "but the heads on this engine are just beautiful. The castings are very smooth and consistent."

Lycoming began developing the 390 while it worked on a larger engine for Cessna; add two cylinders to the 390 and you get the IO-580. The stroke is the same as the angle-valve IO-360 engine found in aircraft such as the Piper Arrow and the Mooney 201. But the bore is .194 inches greater—5.319 vs. 5.125. "An increase in bore is always preferable to an increase in stroke for thermodynamic reasons," says Barrett. The head design is essentially the same as the 360—except for changes to accommodate the greater bore—and has valves of the same size. The compression ratio is the same as the IO-360 at 8.7:1.

Barrett has put several IO-390s on his dyno. The engine is rated for 210 horsepower at 2700, "but we have had most of them exceed that figure. I don't want to say exactly what they did, but it's safe to say that 210 is the very least you can expect from the 390."

"The engine has no detectable rpm limitations," says Barrett. That means you can use a variety of props without worry about restricted rpm ranges. Some versions of the parallel-valve 360 do not come with crankshaft counterweights, so they have to be carefully matched to the propeller and even then may have rpm restrictions for continuous use.

One of the big worries about switching to the angle-valve Lycomings is increased weight. But Barrett says the 390 is just 10 pounds heavier than the parallel-valve engine. "We add a lot of horsepower for not much weight." Fuel burn is up over the 180-hp engine, as you would expect, but the best specific fuel consumption is slightly better than for the parallel-valve designs.

Barrett sells the IO-390 with an Airflow Performance fuel-injection system in either front or rear mounts for $30,600. Barrett can be reached at 918/835-1089 or www.bpaengines.com.

The standard Lycoming induction system is at the top, Superior's below. You are looking at a cutaway of the induction plenum, carburetor side facing down. The bulge smooths airflow.

Superior offers three compression-ratio options for the XP-360, two of which can use autogas as an alternative to 100LL.