

CALL THEM “ubiquitous,” because LS engines are everywhere you look. Delivering a big bang for a modest buck that is easy to tune, the LS continues to rack up satisfied customers in racing circles, straightaways and elsewhere.

Few powerplants have enjoyed such enduring success as that of the LS engine over the past 20 years. But that popularity also comes with a fair share of installation challenges for both aluminum and cast-iron block configurations, regardless of whether the build started with a wrecking yard volunteer or straight off the Chevy Performance warehouse shelf.

Nonetheless, the potent LS engine variants have spawned single-marque, multi-competition racing events. The annual Holley LS Fest at Beech Bend Raceway Park in Bowling Green, Kentucky, has grown to attract more than 1000 cars and 15,000 spectators over three days in September, an extravaganza that now includes drag racing, autocross competitions, a 3S Challenge, Drift Challenge, Track X, and more. In fact, the event has flourished to such an extent that it expanded this past May to include a companion “LS Fest West” at Las Vegas Motor Speedway.

Need more proof? ProMedia’s Chevrolet Performance Challenge Series now requires four different events in the Midwest to serve upwards of 400 anxious competitors.

From major soirées dedicated to the LS to local drag strips across the country featuring cars supplied by its horsepower, the LS is everywhere in auto racing—whether the car sports a Bowtie or some other nameplate. In the following pages we’ll examine why the LS engine has become so popular in motorsports circles—or straight lines and twisty turns, for that matter—and then address the challenges

engine builders and racers face when swapping these engines, along with solutions to maximize performance from this celebrated power source.

Why So Popular?

“The performance of the LS engine is notable, and while the initial cost and headache may exceed other options, the end result is usually rewarding,” said Jessie Coulter of Jessie’s Garage, Bowling Green, Kentucky, who is convinced that the LS engine pushed other platforms to improve their products.

Plus, as LS conversions became easier—or better understood—over time, the engines began showing up in more areas of motorsports. “Not only did Fox body Mustang owners quickly learn that an LS swap was fairly simple, but it increased their horsepower by over 100 along with a weight savings,” added Bruce McKillop of CBM Motorsports, Colton, California.

LS RACE



BY LOUISE ANN NOETH

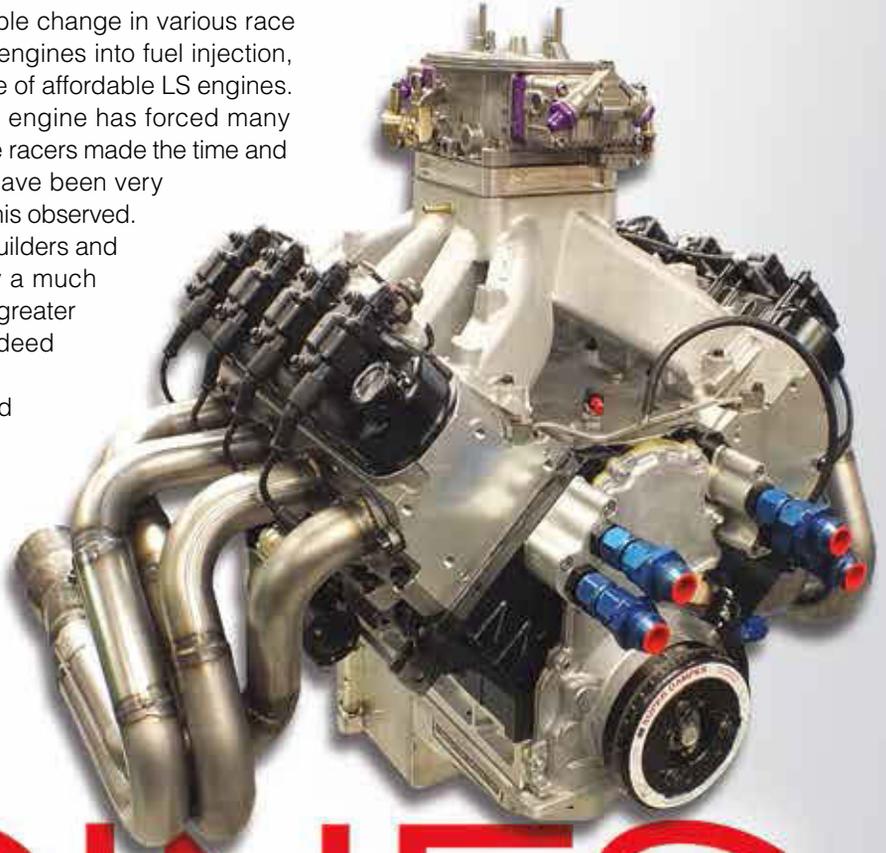
With today's technology, the effort required to make 400 horsepower can be had with a slight tune variation, according to Jack McInnis at World Products in Louisville, Kentucky. He believes the most notable change in various race series is the distinct move away from carbureted engines into fuel injection, a shift that can be directly traced to the abundance of affordable LS engines.

"The difficulty of putting a carburetor on an LS engine has forced many racers to dive into the fuel injection world. And, once racers made the time and equipment investment to convert their car, most have been very surprised at how easy it is to tune the engine," McInnis observed.

You'll get the same story from countless engine builders and high-performance shops: LS engines are simply a much more technologically advanced engine that offers greater horsepower, reliability and affordability; a rarity indeed when all three features earnestly combine.

Part of the enduring popularity, according to Todd Goodwin of Goodwin Competition Racing Engines in Omro, Wisconsin, is that Chevrolet has steadily improved the LS family of engines. "The much improved cylinder head design with raised intake and exhaust ports, and the reduced valve angles of 15 degrees (LS1, 2, 3, 6), and 12 degree (LS7) valve angle, together with improved, high-efficient combustion chamber, yielded higher compression ratios with a flat top piston," he said.

"Gone is the weak small block Chevy's



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EXPERTS WEIGH IN ON SWAPS AND INSTALLS

1.869-inch (47.47-mm) cam bearing journal diameter that was susceptible to breaking," he continued. "GM incorporated 55-mm (2.165-inch) cam bearing journals that reduced torsional flex and increase dynamic stability.

"The camshaft was raised higher, incorporating a one-piece rear seal and replaceable steel stamped rubber embossed front, and rear, cover gaskets, as well as O-ringed intake manifold and valve covers. Inside, they also increased the rocker ratio from 1.50 to 1.70 for LS1 through LS6, and 1.80 for the LS7," Goodwin concluded.

Joe McCaul of Borowski Race Engines in Joliet, Illinois, reminded us that there

is an incredibly high performance ceiling with the LS. "For the right price, virtually any level of horsepower is within reach of LS technology, and its 300-pound weight advantage over a big block, and its more efficient design will out-perform a traditional small block," he explained.

He further noted that "the LS Next SHP iron block weighs 230 pounds, and the skirted aluminum LS Next block weighs 130 pounds," which combined with additional savings from other aftermarket parts "can shave upwards of 200 pounds."

The electronics, too, have become both highly sophisticated and simple at the same time, McCaul added. "Some racers will plug in their laptop at every opportunity to take advantage of the LS tenability," he explained. "Others rely on the inherent

Engine builders and racers are discovering the possibilities afforded by this versatile platform—whether its host vehicle bears a Bowtie or not.

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adaptability of the self-learning EFI systems to focus on other aspects of their vehicle's performance. This latter 'late to the LS party' group often includes a lot of people who are more comfortable with 'old school' technology."

Road racers, autocrossers, drag racers and off-road competitors have different performance requirements, yet the LS serves them all. "If your brand of racing involves turns and braking, more weight is dead weight," said McCaul. "This gives an aluminum LS a tremendous advantage by allowing the vehicle to brake and steer far better thanks to lower weight and better weight distribution.



Engine builders contacted for this report told us that LS engines are technologically advanced and offer superior power, reliability and affordability, with few limits. "For the right price, virtually any level of horsepower is within reach of LS technology," one source observed. Photo courtesy of Goodwin Competition.

"Our shop El Camino pulled 1.29 peak lateral Gs on the Autobahn Country Club road course powered by its 525-horsepower LS1 engine," he added. "With the LS1, weight distribution was near perfect at 48 percent front and 52 percent on the rear."

Yet another venue in which the LS shines is the Trans-Am series and its TA2 class, which uses the LS3 version in its Camaros, noted Kevin Pranger of Katech in Clinton Township, Michigan. "These engines use very few modifications and last an entire race season. Because the LS engine is a natural at making power, many of these classes have adopted inlet air restrictors to limit their true potential," he revealed.

Jay Adams of COMP Performance



Road racers, autocrossers, drag racers and off-road competitors have different performance requirements, and the versatile LS engine can serve them all. Utilizing an aluminum LS engine allows the vehicle to brake and steer more effectively due to lower overall weight and improved weight distribution. Photo courtesy of Holley LS Fest.

Group in Memphis, Tennessee, told us "the LS engine was, and is, a game changer for the racing market. Racers can build a competitive motor for less money than ever before, which opens up a grassroots feel for a lot of racing classes that hasn't been around in a long time. The power-handling ability is unmatched for the price point.

"The LS is in everything," Adams continued. "Swaps that were once seen as sacrilege—'built Ford tough with Chevy stuff'—are now commonplace.

"Pulling the old 302 out of your Fox body? Fit an LS in; it's cheaper to work on, and the parts are more available. With the swap phenomenon came an entire market of swap kits and harnesses to make it possible for every mechanic with nearly any car under the sun," he concluded.

Challenges

As LS engines have grown in stature—not only in their originally sold cars, but as swap-outs with existing engines—a handful of challenges arose.

Coulter, for one, knows that adopting an LS engine can mean starting from scratch. "None of your conventional big or small block parts will interchange. You need all the engine covers, oil pan sensors, etc.," he said. "Engine oiling with a stock pump and pan will starve a race engine. A lot of your factory pans have a pickup point in the middle of the pan, which is a disaster in a high G-force race application.

"The internal oil pump system also seems to be an issue after a certain power level," Coulter continued. "Aftermarket pumps have come a long

way to supply enough volume."

Because LS engines do present challenges during a build, or swap installation, an experienced engine builder or fabrication shop can prove their worth to customers by mastering such a project. Taylor Lastor of TRE in Cleveland, Texas, has a full engine building facility and a full chassis shop, and "for LS combos, our chassis shop builds custom headers in-house, and we stock and install front motor plates, as well as other parts required for final installation," he said.

Beyond parts and fabrication, World Products' McInnis noted additional challenges in philosophy: "The ignition and fuel injection have been the major problem for most racers and engine builders. Most of us don't like change, and going from a distributor to an eight coil electronic ignition, and fuel injection from a carburetor has been a challenge.

"Fitting the engine into a chassis with a cross member has presented somewhat of a challenge due to limited oil pan availability," he continued. "Limited header availability has meant lots of expensive, time-consuming custom headers when swapping an LS into a small block or big block Chevy chassis."

Goodwin believes the high-performance industry has rallied to allow the factory fuel-injected LS engines to be converted to simple electronic ignition and carburetion. "Aftermarket front timing covers that accept a common GM-style distributor can be installed along with a traditional-style single, or twin-four-barrel intake manifold, to run carburetors.



Depending upon what transmission the customer uses for racing will determine if the engine needs a crankshaft spacer to hook up to it," he said.

Katech's Pranger views building a race car as an adjustment exercise for designers, fabricators, and artists to turn vision into reality. "Most car builders are just that—builders of cars, not assemblers of off-the-shelf components—who adapt

"The LS engine was, and is, a game changer for the racing market."

various materials into a vessel built for speed that is governed by a set of rules produced a sanctioning body," he said.

"The LS6 was one of the first LS engines to be adapted into circle track racing in what was the ASA series. GM and Howe Racing worked together to adapt a proven chassis, which ran carbureted small blocks, to a proven engine with electronic fuel injection. The challenges were merely the installation of the electronics and all the supportive sensors that went with it," he noted.

Platform Solutions

Despite their eccentricities, LS engines can be optimized with some advance understanding of their nuances and a steady flow of aftermarket innovations.

Take Borowski Race Engines' McCaul, who told us his company uses Dart LS Next blocks as "our platform for big power builds. Using their blocks as an example, the original designs were skirtless, and required special oil pans, remote oil filters that could not accept the OE accessory brackets. Dart has since begun to offer these blocks with skirts, thereby simplifying installation.

"Another example came from a fabrication shop that did several installs of our Whipple supercharged crate engines," he continued. "They now offer a

kit, including the intercooler radiator and a variety of fittings, to greatly facilitate the installation process."

With that in mind, our sources offered a handful of tips to consider when executing an LS swap or install.

"Make sure you do your research on the engine's computer control modules," advised CBM Motorsports' McKillop, "especially the ability to change the tune, because many of these systems are locked and require an additional fee to be able to tune them."



Owing to its incredibly high performance ceiling, the LS engine has grown increasingly popular over the years, with classes and events—like Holley's LS Fest and LS Fest West, and the NMCA Muscle Car Nationals (seen here)—dedicated to the platform.

Goodwin mentioned race programs that were delayed, or saw initial costs balloon, because racers or teams weren't comfortable tuning via a laptop computer. Many were either forced to learn, or had to rely on outside sourced tuning help. "Individuals that lacked the knowledge, yet tried to tune, often failed, suffering engine damage," he observed. "The biggest tip to keep in mind is [that] the money you spend getting the tune right could save you ten-fold on a blown-up engine experimenting!"

Coulter noted that aftermarket fuel management in a full-on race application is basically the standard, and that engine management is the end user's choice. "Keep in mind the scope of the application, but also think about where the project may end up in the near future. For example, a stock ECU will work fine in a mild, naturally aspirated application. But when power adders are used, they do have their downfall in a race application.

Remember, custom parts can easily be double that of an off-the-shelf part."

Also, understand that most aftermarket crankshafts present reluctor wheel challenges. "The engine management uses the signal from this part to know where to start timing and fuel events," Coulter explained. "At higher rpm, if this wheel has a lot of run-out it can lose signal and shutdown. Going to an external wheel is usually the fix."

World Products' McInnis advised racers to take their time and weigh all available options before committing to an LS swap. "Sometimes the inexpensive, used LS engine is not a good deal when you look at all the parts it will take to put the engine into the car," he said. "Remember to add a few hundred dollars for tuning at a shop with a chassis dyno, because you won't get the full value without tuning the engine properly."

TRE's Lastor suggested a detail-oriented approach. For example, he believes buying a flywheel with built-in converter-to-crank adapters is helpful, but more importantly, "getting all the metric fasteners from a supplier like ARP is a must.

"One of the idiosyncrasies of the LS is the proper bleeding of the cooling system," he added. "Because of the design of the bypass thermostat system, you have to fill the cooling slower than you normally would."

Borowski's McCaul understands that no one wants to perform destructive testing on parts, or engines, so what's the best prep? "Generally, I like to get an idea where the cliff is, and back up about 20 percent from there. Our dyno is rated to 2500 horsepower, so I don't really want to run it past 2000 horsepower. One engine was tested at 22 psi boost. We dyno'd to 1929 horsepower and then removed the heads to check the gaskets, because the customer planned on taking it to 30 psi boost.

"The Cometic NLX gaskets looked perfect," he continued, "and they were considered the weakest link. Net result is that we were comfortable at 30 psi and can infer 2375 hp at that level of boost.



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With a bigger budget, we could use a billet aluminum or CGI iron block, copper head gaskets, and some other upgrades in order to target 3000 hp.”

The proliferation of LS race engines, noted Keith Jessee of Holley Performance Products in Bowling Green, Kentucky, has helped generate an abundant supply of parts to ease the retrofitting process. However, he did note that just like with any other new technology, there is a learning curve to the LS. “Many racers run carburetors on LS engines for simplicity’s sake, but the engine design engineers optimized the intake manifolds and cylinder heads for EFI. Controllers, like our MSD 6014 and Holley EFI, make these things much easier to deal with compared to making a factory ECU work.”

He also noted exhaust considerations: “We offer comprehensive swap kits under the Hooker brand that optimize driveline angles and offer ideal fitment with high-flowing premium exhaust pieces.”

Another product specifically developed for the LS platform is the Powerhouse LS main cap tool from COMP Performance Group, which allows the user to quickly and easily remove the main caps on an LS engine without damaging the doweled holes. Chris Potter told us that “it ensures a direct, even lift of the cap to prevent distortion, preventing the need to pry on the block. One swift motion and the cap is safely removed.”

For camshaft swaps without removing the cylinder heads, Potter pointed to the Powerhouse LS lifter retaining tool. “The stock lifters are guided and retained by a set of plastic trays in the valley that deteriorate and wear out over the life of the engine. When removing a camshaft, it is possible then for a lifter to fall out of the guide and either block the cam from coming out of the block or, worse yet, dropping all the way into the oil pan.”

Potter referred to this tool as inexpensive, preventive insurance. “These retain the lifters around the oil band,” he said, “preventing them from dropping too far into the cam tunnel.”

Katech’s Pranger noted that while the bellhousing bolt pattern remained the same as in the small block, the crankshaft

flange did not. “It is located closer to the rear face of case than the SBC,” he said. “ATI Performance Products produces a spacer and appropriate flywheel to aid in the adaption of the LS engine to an older style GM transmission.”

Speaking to its high-end LS engine builds and installations, McCaul told us that at the Borowski shop, “we have two major problems: lead time and costs. Higher-end parts can have very long lead times, because manufacturers produce in batches once they have a sufficient backlog of orders. They may say 16 weeks, but it can turn into six months.

“Our countermeasure is to maintain inventory of key parts,” he said, “which raises our costs above the already high cost of the parts themselves.

“[But] some costs are coming down,” McCaul noted. “The new Holley Sniper EFI system is about half the price of the comparable systems from just a few years back. Also, the Dart SHP LS Next block lowers costs significantly compared to their original skirtless design.”

World Products has developed an engine block that represents a hybrid LS/SBC design utilizing a traditional Gen I small block configured to accept the LS cylinder heads and intake setup. “This simplifies installation in a chassis where an older style engine was used because the engine mounts, oil pan configuration, cooling system and bellhousing are all SBC style,” explained McInnis.

“These are typically the things that cause the most headaches when swapping an LS engine into a vehicle that formerly had a traditional small block, because the top end of the engine is where the LS has its advantage. By virtue of the superior cylinder head design primarily, World’s hybrid block offers LS performance while preserving the familiar features of the SBC design,” he added.

While several manufacturers have already addressed ways to improve the LS engine, are there additional areas where they see potential? Borowski has worked with transmission suppliers to

make sure customers would have a reliable drivetrain, according to McCaul. “We now pass along the engine dyno sheet to a transmission supplier, along with the details of the vehicle, and intended usage. This allows a durable, tailor-made pairing,” he said.

For racers who may be less skilled in fabrication, TRE’s Lastor would welcome more bolt-on accessories for racing engines. “Things like crank trigger kits, pulleys systems, external oil pump/dry sump,” he listed. “Because we have to fabricate all those things ourselves.”

Both Pranger and Goodwin suggested a more cost-effective complete engine management system that’s easier for the end user to operate.

“A lot of customers can’t afford to hire a professional to tune their engine, so they struggle through it themselves, and call numerous times for tech support and answers, usually after they have already damaged their engine,” Goodwin noted.

Added Pranger, “There are many fuel injection controller companies out there—just make sure you work with one that understands which generation of LS engine you have, [as] the crank and cam patterns vary between generations.” 

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