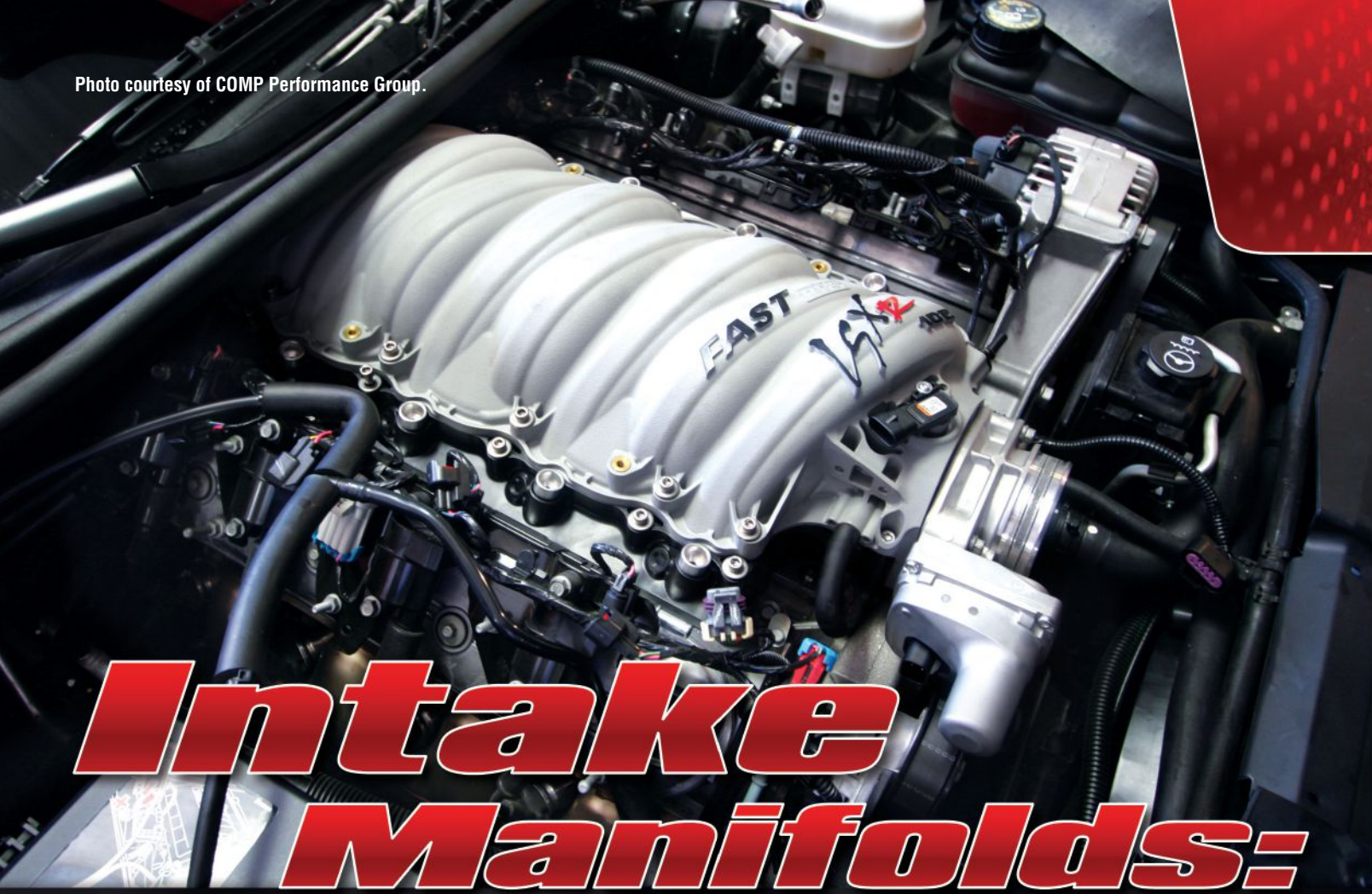


Photo courtesy of COMP Performance Group.

Intake Manifolds: Keeping Up With New

By Nick Gagala

ON an application-to-application basis, any new developments in race intake manifolds are driven by the latest changes to other engine components, especially cylinder heads.

"Larger cubic-inch engines are becoming more common and bigger all the time," said Curtis Boggs of Race Flow Development (RFD), Lorton, Virginia. "The primary trend will be the advancements in cylinder heads. Better heads require better manifolds.

"The designs will follow engine demands. As the engines get bigger or the rpm goes up, the demand for better induction follows. Typically, heads and manifolds of today have better use of proper area and better velocity profiles," Boggs added.

Tony Mamo of Air Flow Research, Valencia, California, said the following about intakes geared toward drag racing applications: "A walk through the PRI or SEMA Show would quickly convey the sheer size and proportions of some of the latest racing manifold designs. These are very single-focused pieces designed for moving large volumes of air at higher rpm's, but five years ago, or even less, you wouldn't have seen some of the aggressive stuff you see on the market today."

Richard Maskin of Dart, Troy Michigan, said his company's line of 23-degree small block Chevy manifolds are still very popular. "In the 1980s Dart developed and manufactured a 23-degree manifold for GM called the Bow-Tie manifold. It was used on Gen 5 and Gen 6 GM heads as well as aftermarket heads of the day. Fast forward to 2014 and not much has changed," he explained. "Yes, engines make more power for a variety of reasons. Parts are just better and we have 30 or so years behind us, but the physics are the same. The manifold is an extension of the intake port and the shape of the cross-sections from the valve to the air source must have the same characteristics of the 1980s. We tell our customers to be careful not to put too big of anything on their engine. The drivability will surely suffer and they won't be happy."

Shane Weckerly of Holley Performance Products, Bowling Green, Kentucky, said intake manifolds are better today largely due to advances in design and fuel system technology. "Computational Fluid Dynamics allows the designers to 'see' the airflow during the design process, maximizing port and manifold efficiency," he said. "In addition, EFI systems have allowed better control and opened up new horizons with turbocharging, supercharging, cylinder-to-cylinder fuel controls, etc."

Kevin Feeney of RHS and FAST, part of the COMP Performance Group, Memphis,

Several factors influence development of the current lineup of race intake manifolds, and manufacturers describe those innovations that most affect their latest creations.

Tennessee, said today's technology allows for the production of more efficient parts, including intake manifolds. "The variety of computer-aided modeling software enables us to design parts faster and more precise," he explained. "What once took months to complete can be achieved in a matter of weeks. In addition, the advancements in manufacturing have provided the ability to produce lighter parts at an affordable price."

Scott Patton of M & M Competition Engines, Indianapolis, Indiana, said if the past is any indicator, intake manifolds are often the last to receive updates. "I believe that the past few years have seen more positive changes in intake design than any time in the past," he said. "With that said, the only advances I see in intake manifold design in the near future are going to be the application of proven existing technology into all platforms of racing. What has worked for one form of racing or one type of engine platform will be adopted by other forms of racing and other engine platforms."

Here's a look at some of the developments in the race intake manifold market.

Inside Intakes

At press time, Dave Born of Ford Racing Performance Parts, Dearborn, Michigan, told us the company was leading the design and development of a new composite intake manifold specifically designed for the 1.6L SCCA Gen 3 Spec Racer. "It is a purpose-built manifold designed to the SCCA's specification to work within their specialized environment that helps deliver a great performing and very consistent and reliable engine," he said.

Ford Racing was also in the early development phase of a replacement intake manifold for the Cobra pushrod small block 5.0Ls when we spoke. "We will be introducing a new composite version that we are very excited about within the next year," Born said.

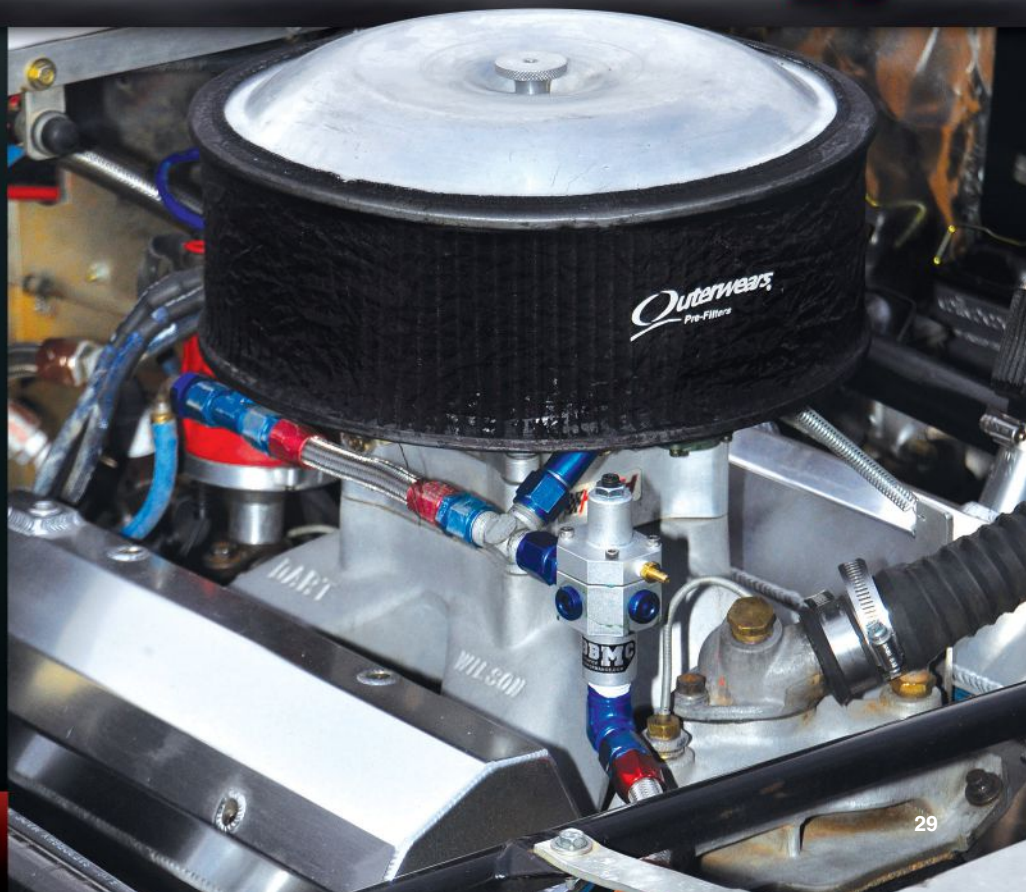
The company was also working on a specialized intake manifold for use with a naturally aspirated Cobra Jet vehicle that races in the NHRA. "This composite part is for a large-displacement, high-revving, high-horsepower small block that should really turn some heads," said Born.

Composite manifolds are proving to be as great performers with improvements in finish/smoothness of the internal surfaces for better flow, according to Born. "Composite material provides less heat retention in the air, resulting in a denser charge and greater power when compared to metallic manifolds," he said. "Additionally, they offer a weight reduction when compared with metal.

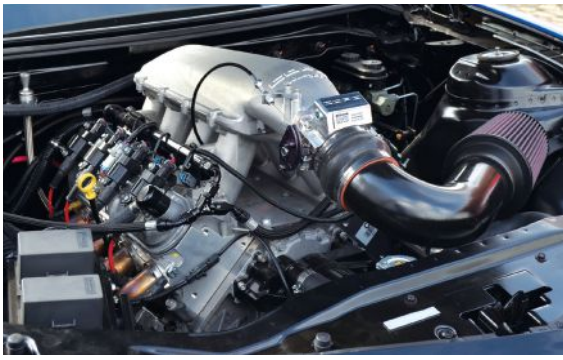
"Lastly, since they can be molded with many features in net shapes, there is minimal machining and assembly work required that results in less complexity. Our last two major introductions—the 5.0L 4V Cobra Jet intake manifold for Coyote and Boss engines, and the 4.6L 3V performance intake manifold—were both done in composite, and our plans for the future will continue this technology," he added.

Brent McCarthy of Edelbrock, Torrance, California, reported a variety of new intake manifold developments for the company. "This year we've introduced a modern big block Chevy tunnel ram for conventional rectangle port heads with versions for

Cylinder Head Technology



carburetors and for EFI," he explained. "We made LS3 Super Victors for both Dominator 4500-style carburetors and 4150 square-bore carburetors. We added a Dominator flanged SB2 Super Victor (PN 2884). We also expanded our line of CNC port matched Big Victor 2 manifolds for all popular heads on either short- or tall-deck blocks. We now offer port matched versions of our Super Victor II big blocks to fit our CNC ported 377cc heads. And, we created a tall-deck version of our Super Victor II machined especially for the Brodix SR-20 cylinder head.



Advances in design and fuel system technology are contributing to the development of better intake manifolds, reported one supplier. Computational Fluid Dynamics (CFD) allows designers to "see" the airflow during the design process, maximizing port and manifold efficiency, he said. In addition, EFI systems have allowed for better control and opened new avenues in turbocharging, supercharging, cylinder-to-cylinder fuel controls, etc.

"Our pattern-makers and foundry have worked diligently to design tools that create extremely smooth divider walls and plenum areas right out of the box," he added. "There is no finish work required. Also, we are profiling the port exits on our Super Victor small block and LS3 manifolds. It works great out of the box, but if you wish to smooth out the runner further, you have a great starting point."

In the next five years, McCarthy said he sees CNC-ported heads with a CNC-matched manifold sold as a package becoming more popular. "We also expect more naturally aspirated EFI people to use tunnel-ram manifolds with high-mount injector locations. The power gains over a single 4V throttle body are just too much

to leave on the table," he said.

McCarthy offered the following advice to engine builders and racers buying an Edelbrock intake manifold: "Our manifolds are machined to fit standard-block deck heights and standard-head intake flange locations. Fit should be verified before installing. Most manifolds will benefit from a port match. If you are fitting a racing manifold to a ported stock head, some flange trimming may be needed. Aftermarket race heads won't have any issues. If you are using carb spacers, make sure they fit properly, that their opening lines up with the manifold plenum, or hangs just inside of it."

A new racing intake manifold from Hilborn Fuel Injection, Aliso Viejo, California, is for large-bore 426 Hemi engines. "Available in MFI or EFI, the 2 7/8 bore can handle the big power potential of the larger cubic inch Hemis now available on the market," said Andrew Starr.

Hilborn offers ceramic-based coatings for durability in the race environment, Starr told us. "We have larger fuel rail sizes to mitigate the pulsing from larger injectors. We also have dynamically flowed EFI injectors to ensure correct port-to-port fueling throughout the dynamic operating range of the injector," he explained.

Starr agreed with other contacts who said that big-cubic-inch engines and the corresponding increase in power are driving new intake manifold designs. "We know that part of any system design includes matching the butterfly size to meet the expected output of the engine. Bigger engines need bigger butterflies," he said.

"Synchronization of the butterflies is a key to providing proper operation," Starr continued. "We have online videos and supply a synchrometer with every manifold to allow the owner to fine tune them for correct operation from idle to WOT. Yes, it is extra work, but I have yet to have a customer tell me that the end result was not worth the effort."

Patton of M & M Competition Engines said, "We have found that the industry has been begging for larger intake

Intake Manifolds

manifolds to keep up with today's higher flowing cylinder heads. Our latest intake (the MM-3 single four spider intake manifold for the SB2.2, M & M Revolution and M3 cylinder heads) has filled that need. With proper plenum volume and design, larger runner cross section, and engineered equal runner lengths side to side and front to back, we have produced an intake manifold that will supply the larger cubic-inch engines with the proper air/fuel that is required for 460-plus cfm small block cylinder heads."

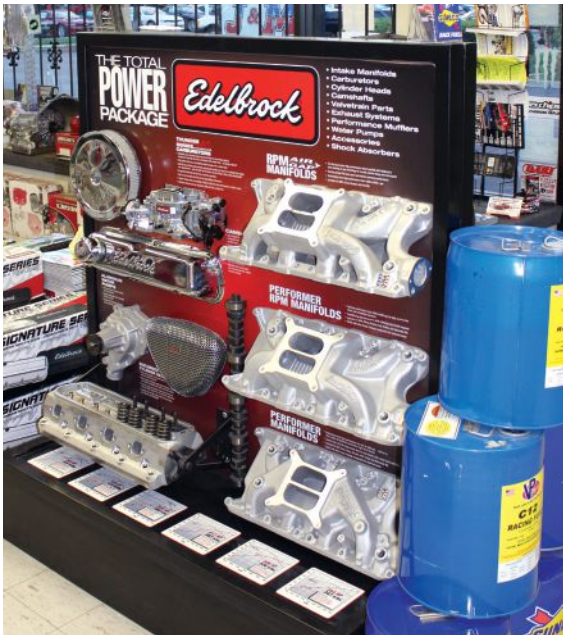
As today's common engines are trending toward larger displacements, the cylinder head market has been forced to increase not only port size, but increase flow numbers as well to keep head design efficient, Patton told us. "The final step, which is so often overlooked in the industry, is engineering intake manifolds to complement the larger CID engines and higher flowing cylinder heads," he said. "All of our intakes, whether it be a custom sheet metal or a fully CNC'd cast intake, keep these necessities in mind. It is a must to properly size the intake runner length, taper, cross section, and 'line of sight' to produce an engine that will run to its potential. Our intakes accomplish that goal.

"Of course, material changes and casting processes have increased the manufacturing efficiency, but the largest impact that I see in the production of intake manifolds in the past five years is the introduction of CAD/CAM design at a grassroots level," Patton continued. "With computer-aided design, what used to take weeks or months now is available at the click of a mouse. This has enabled our company to branch out and really fine tune our designs and offer our customer base a larger selection of intakes to truly fit their needs."

Jason Neugent of Brodix, Mena, Arkansas, said his company's latest small block intake manifold, the BM1000, is "a good overall 23-degree intake for a lot of different classes, including the circle track guys, and it also meets the standards for any drag race application. It has a good rpm range. It's set up for a 4150-style carburetor."

The company's best-moving big block intakes are its BM2017 and BM2027 models, he said. "The only difference in those two is the 2017 is a short deck and the 2027 is a tall deck. We have a built-in 'turtle' in those that helps itemize the fuel, bust up the fuel, send it out through the engine more efficiently, with a little better torque curves and horsepower gains with it. The turtle is already cast in there.

"We have our own foundry, so it makes sense for us to cast our own intakes and have intakes available for the heads that we build," he added.



Retailers should draw customers' attention to the newest intake manifolds available at their racing shops with an attractive retail display. Presenting the related cylinder heads will show customers what products were designed to work together, which also makes the shopping—and buying—process much easier.

Manifold Options

Mike Weinle of Weinle Motorsport, Cleves, Ohio, told us that his business is booming. "We are having a great year and are really busy doing a lot more high-tech manifolds," he said. "We have a new CNC-machine building. We are building billet runner manifolds, shear plates, burst panels and CNC heads. More and more people are requesting billet runner manifolds and custom designs. With our new

CNC machine, we can design, make and machine manifolds."

Dart's Maskin stressed that in the world of normally aspirated engines what's old is new. "As the heads and other related components have gotten better the manifold still has the same job," he observed. "You must consider displacement of the engine, its use—drag, street, off-road or oval track—and rpm range. With this information good decisions can be made for all your parts including the manifold.

"In the 23-degree world, the engines can be very powerful, but with other heads making much more power in this day and age, let's stick with the basics," he added. "Don't overdo it looking for 15 or 20 more horsepower. This means it is easy to get too big in the intake track and give up the throttle response and gear recovery that is necessary to be fast."

Mamo said Air Flow Research is adding a new plenum/spider to its popular line of 23-degree SBC two-piece composite intakes. "It's a 4500 series Dominator flange racing single plane that is about an inch taller than our current TXR 4150 based piece, and it has a larger plenum and much taller runners aimed at feeding a deep breathing 23-degree SBC," he said. "Either a large CID application or a high winding aggressive smaller engine would also benefit from the new design.

"The two-piece interchangeable design—a universal base plate allows you to swap different style spiders or runner configurations—and much lighter, much cooler composite construction has been well received by many of the different racing bodies—be it circle track, drag, or just a street/strip car looking for an extra competitive edge," he continued. "It weighs close to half of a comparable aluminum manifold and, due to its composite construction, runs about 30 degrees cooler as well, helping the engine to see a denser intake charge and added power."

Mamo told us that Air Flow Research has been trying to design its single-plane manifolds so that the runner lengths are more balanced by extending the shorter runners and shortening the

longer runners. "It makes for an interesting plenum design, but, in our opinion, the end result is each cylinder doing a more even share of the power production—less variance in output from cylinder to cylinder—and ultimately creating more power and torque in total."

Holley Performance Products has been proactive in designing new modular intake manifold systems for the LS engine series, called the Hi-Ram, Weckerly told us. "The cast modular design allows racers to have the benefit of a sheet-metal-type tunnel ram in a more cost-effective package," he explained. "The manifolds can be configured for carburetors, 4 bbl MPFI or traditional LS forward-facing throttle bodies for N/A or forced-induction applications.

> **"Five years ago, or even less, you wouldn't have seen some of the aggressive stuff you see on the market today."**

"In addition, Holley is pleased to be releasing several versions of our single-plane carb and MPFI-style cast aluminum intake manifolds for the GM LS series engine very shortly," Weckerly continued. "These manifolds allow a racer to install an LS engine while maintaining the simplicity of a carburetor or to give a great old-school look without giving up an ounce in technological advancement. They are also ideal for blow-through applications or for forced induction with an elbow."

Holley is also releasing carbureted-only, dual-plane intake manifolds for GM LS applications. "All versions of the intakes are available in LS1/2/6 and LS3/L92 variations, and the Hi-Rams are available with an LS7 version as well," Weckerly said. "In addition, we will be re-releasing some popular big block Chevrolet racing intakes that we have updated for EFI.

"Most of our new intakes are now being equipped for EFI injectors and fuel rails.

The market is rapidly adopting EFI, and consumers need all the hardware components to make the swap," he added.

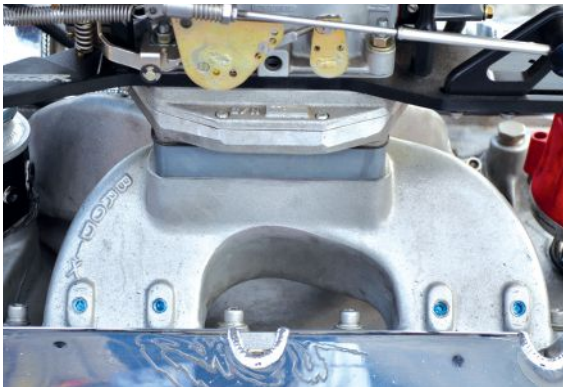
Bill Mitchell Jr. of Bill Mitchell Products (BMP), Ronkonkoma, New York, explained, "Since BMP took over the World Products aluminum line, we have been working on positioning ourselves better at state-of-the-art foundries and machining centers to raise the bar on our quality. In addition, we have been making many changes to the product line to improve on the parts themselves."

Mitchell added, "There are more and more people that want to simply unbox the part and bolt it on and go. This comes back to the quality of the part and leaving nothing on the table for the engine builder having to modify this or that to fit it."

Feeney said both RHS and FAST continue to refine the designs of polymer intake manifolds for the LS engine platform. "The unique modular design is the choice of the top engine builders for its ability to remove the individual runners for porting," he said. "The LS platform continues to grow at an exponential rate, and the common place of large CID engines requires this flexibility in manifold design, so an engine builder can tailor the port cross section to optimize the torque curve for their specific combination.

"We continue to put a lot of emphasis on our EFI manifolds and our injector placement, particularly on the 4 bbl designs," Feeney continued. "The traditional manifold was designed for the flow characteristics required for the air/fuel mixture created by a carburetor. Our engineers at FAST invest a lot of time analyzing the flow pattern through the entire intake tract to maximize the efficiency of flow through the manifold and proper placement of the injector so the flow patterns work in unison. Our RHS/FAST 23-degree manifold is an example of this with its unique injector placement."

Feeney offered the following advice to race engine builders and racers: "Similar to choosing a cylinder head, bigger is not always better. The size of the engine and application—circle track, drag race, etc.—all need to be identified. Then, the engine builder needs to determine what the expected target horsepower and torque is and what the desired rpm band is. The manifold that makes the most peak horsepower is not necessarily the best choice if it is not in the operating range of the engine. Defining the rpm band will provide the engine builder with the ability to choose a manifold that will maximize power, torque and throttle response where and when it is needed.



When choosing an intake manifold for a race engine, one supplier explained that the process is similar to that of choosing a cylinder head—namely, bigger is not always better. First consider the size of the engine and application, such as circle track, drag race, etc. Next, the engine builder must determine the expected target horsepower and torque, as well as the desired rpm band.

"With the variety of manifolds available today, and with today's manufacturing techniques, most manifolds do not require additional work and can be bolted right on," he added. "However, it is critical to ensure that when bolted on, the intake and cylinder head ports are properly aligned and the distributor height is correct in the block. Both of these will be affected when the block and/or cylinder heads have material removed from the deck surface."

More Trends

Cody Chapman of Chapman Manifolds, Las Vegas, Nevada, said his company's newest manifolds consist of a 100-percent machined from billet 6061-T6 aluminum. "The manifolds are constructed as a bolt-together unit, giving you unlimited design opportunities," he said. "Because they are billet and

CAD designed, it opens up many doors for unique ideas to come forward with a reasonable price and much shorter lead times.

"Our manifolds have a very unique new feature that we came up with to give the engine builder another tool to improve performance and efficiency for their customers," he continued. "We separated the manifold into sections that all engine builders look at to improve. The old way was to change certain areas using either a welder or epoxy, and then moving things around where you wanted them. Our way is to make the manifold 'fully tunable' to make it a lot less time consuming and quicker to make improvements to your combination."

Kinsler Fuel Injection in Troy, Michigan, offers its billet 410 intake manifold for small block Chevys, Fords, and more applications. It features all ball-bearing support of the longitudinal throttle shafts, including the bearing between each set of butterflies.

Brad Cauzillo said, "This gives super smooth throttle action, allowing better control of the car on the track. These manifolds can accommodate any port design the customer wants. Kinsler can help the customer select a port for his engine combination by varying both the shape and volume of the CNC ported runners. The manifold was released in February, and Kinsler has already made some extreme variations to suit customers."

"There are more and more people that want to simply unbox the part and bolt it on and go."

Boggs of RFD told us the company's manifolds evolve with the development of its cylinder heads. "Most of our manifolds are custom-fabricated sheet metal or billet. The cast manifolds we offer are typically custom-ported for the application," he said.

"The new features would be based on development, percent of taper, plenum size, runner length, etc., and are all evolving on a daily basis," Boggs added. "We are seeing a trend toward higher rpm combinations that translates to shorter runner length in manifolds."

Matt Bieneman of MBE Cylinder Heads & Manifolds, Mooresville, North Carolina, said that company is working on a CNC program for dirt Northeast modifieds. "That will take seven pounds off the manifold," he said. "It will almost look like a billet piece when it's done. That will be available probably around August 1.

"Now that the valvetrain is more stable up to higher rpm's, the runners themselves need to be larger and the plenum volume itself has to be larger. As those rpm ranges go higher, on the cast manifolds we have to shorten the runners when we port them also to move the power band up higher," he added.

Some of Kinsler's manifolds have been made for EFI road racing and for street use, with throttle position sensors, fuel rails, and nozzle bosses for EFI nozzles.

Sonny Leonard of Sonny's Racing Engines, Lynchburg, Virginia, told us the company's latest intake manifold is CNC machined from billet aluminum material. "Our manifold will have machined bosses for fuel injection and nitrous oxide," Leonard said. "CAD modeling is the trend for the latest change in technology. We use Solid Works for design and Mastercam software for machining."

Indy Cylinder Heads of Indianapolis, Indiana, produces its manifolds for Chrysler applications. "I'm making a new Hemi manifold for a short-deck Hemi," Russ Flagle said. "But all we do is just tweak our manifolds that we have now, do things to them that we know are going to make a little more horsepower. These are all just small changes. We've pretty much covered the complete Chrysler world, from the AMC engine to the 360 to the Gen 2 and Gen 3 Hemi.

"That's all we've done since 1990: We try to fix the problems that Chrysler gave us. We've come a long way with doing that," he added. PRI