C&L Performance's New Three-Valve Intake Manifold - Expand the Limits

Rumors of its existence have been going around the Internet since the first prototype went out the door for testing. It wasn't long before the buzz turned into reality and the MM&FF staff received C&L Performance's first production intake manifold for the Three-Valve Mustang to flog on the dyno just for you, the reader. Over the course of the last three years or so, C&L proprietor Lee Bender has been constantly refining his latest product to make sure it was the absolute best it could be. Finally, the Internet buzz turned into reality, and C&L Performance's first production intake manifold for the Three-Valve Mustang was ready to be flogged on the dyno.

"In 2003, we were the first company to develop an upgraded upper intake plenum for the '96-and-up Two-Valve 4.6L Mustang, and that product was a huge success at the time," says C&L Performance's Lee Bender. "Our '05-and-newer products quickly accounted for the highest percentage of our overall sales. This led us to evaluate the factory Three-Valve intake manifold to determine what improvements could be made. Although the factory intake does have a higher flow capacity than the stock cylinder-head intake-flow capacity, it still fell short of the CNC-ported heads that serious enthusiasts were using." While the factory plastic intake manifold

saves weight, Bender believed its plastic construction wasn't ideal for high levels of nitrous oxide.

"By implementing individual port bosses for a direct-port system, our manifold allows enthusiasts to safely run as much nitrous as they are comfortable with, without fear of backfires, fuel accumulation, or fuel puddling issues," notes Bender. "In our dyno testing, the manifold has shown that clear gains are afforded by the intake manifold on everything from a totally stock engine (11-14 hp) to a fully built engine. The better the heads flow and the higher the engine operating rpm, the greater the potential gains are with the new manifold design. It's a natural for high-boost applications as well."

Designing, testing and producing your own intake manifold is no easy feat-in fact it's a major undertaking.

"The first flow testing for our original production runner designs (for comparison with the original manifold capacity) took place in May 2007," says Bender. "The manifold has gone through two completely different sets of tooling and two different runner configurations since the original design.

"The last seven months of the product development cycle was spent optimizing various characteristics of the manifold with valuable help from independent third-party testing. We had to ensure that the manifold's final configuration was flexible enough to support the needs of those with high-rpm engines, while doing all that we could to maintain good overall performance for those who have cars that operate below 6,500 rpm. The first cast samples were created over a year ago, and the first true production samples (with a revised intake port runner) were cast in July 2009.

Getting down to specifics, we asked Bender what the main differences are between the C&L intake and the factory plastic piece.

"Aside from its aluminum construction, which is a substantially more durable material, it features an individual intake port flow capacity that is roughly 28 to 30 percent greater (on average) than the original intake," notes Bender. "This was accomplished by eliminating the crossover runner design of the factory manifold. By keeping the port entry location for each respective bank of runners away from the other, we were able to maintain the same port shape throughout the entire runner. The stock crossover manifold (due to front-to-rear-port length and spacing) has to convert the runner from a round opening to the oblong shape of the factory port at the cylinder head. The runners are length-tuned to develop a horsepower peak that starts at around 5,000 rpm and extends to at least 7,000 rpm, and even higher if the engine is built to operate above that range.

"The total manifold volume has been increased by 1.1 liters, which gave us the best overall performance at all rpm points during testing. The factory charge-motion-control valve plates are completely eliminated when installing this manifold, and this saves the customer the trouble of having to purchase aftermarket delete plates.

"Every major characteristic of the manifold was adjusted and thoroughly tested to ensure we had the best possible configuration. This testing, along with that of third parties using various configurations, added substantial time to the finalization of the product, but it also ensured we had done everything that we could to optimize the product."

In noting the aluminum construction of the C&L intake manifold, we asked Bender why he opted for this material versus the factory plastic composite. "Composite manifolds are ideal for OEM automotive manufacturers, as they offer a very low-cost product when you're creating very high volumes of manifolds," says Bender. "The up-front tooling costs are several times

higher than what it costs to develop a mold for an aluminum product, but if the volume is there, the cost savings per unit can more than make up for it over time.

"Composite tooling is created from 3D CAD models in software. Once the tooling has been cut, it may be necessary to completely redo it if you need to make a substantial revision or change to the product. This can become very costly, which is why most parts made in this manner are tested as 'rapid prototypes' first, to evaluate and make adjustments until the product is right. Although these prototypes can be made rather quickly, they are quite expensive to create.

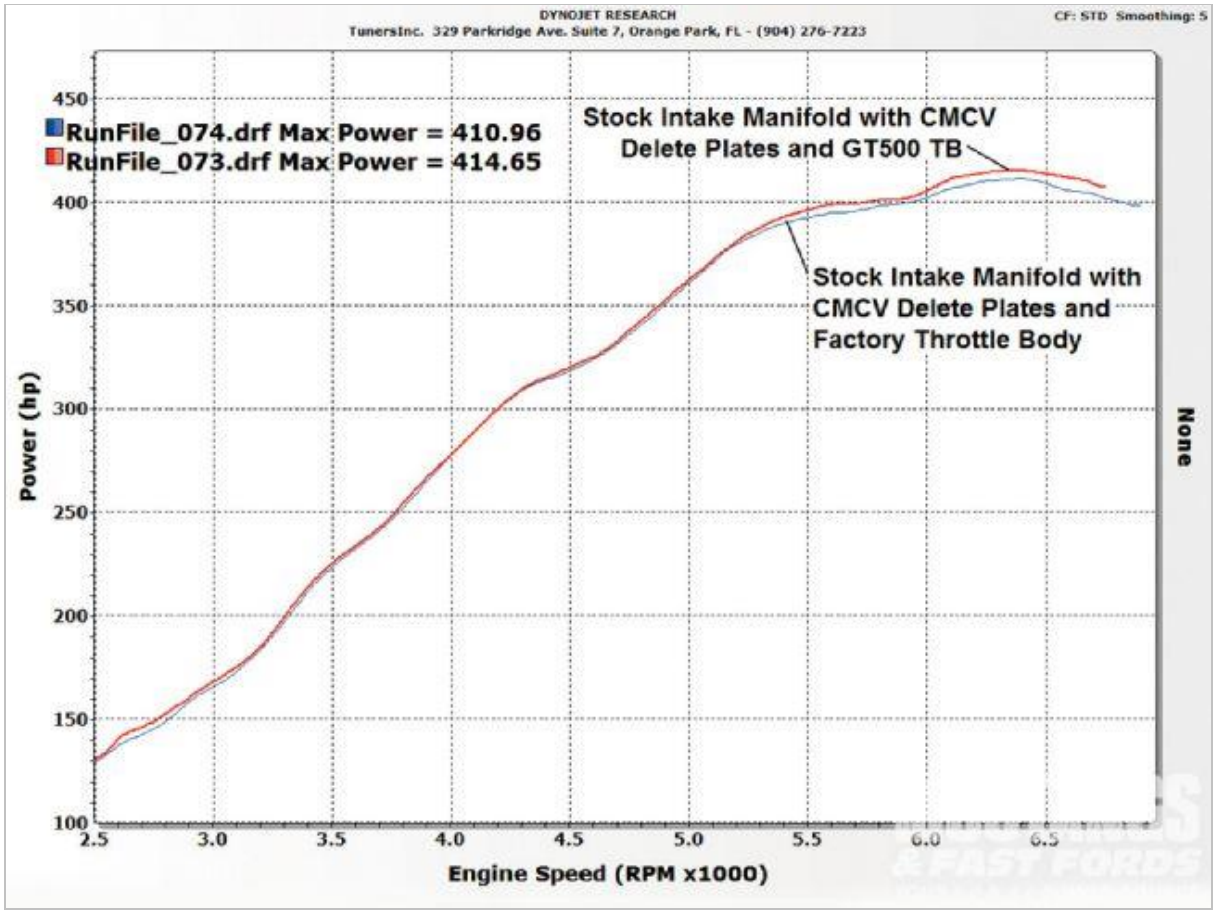
"We take a very hands-on approach to product design and development. Although 3D modeling is becoming more commonplace within our business, I still prefer to do most things by hand. In the performance aftermarket, the sales volume in most cases simply does not lend itself well to using composites for creating intake manifolds. The up-front tooling costs for aluminum castings may be less, but the time required to make revisions and adjustments is longer than with rapid prototyped parts."

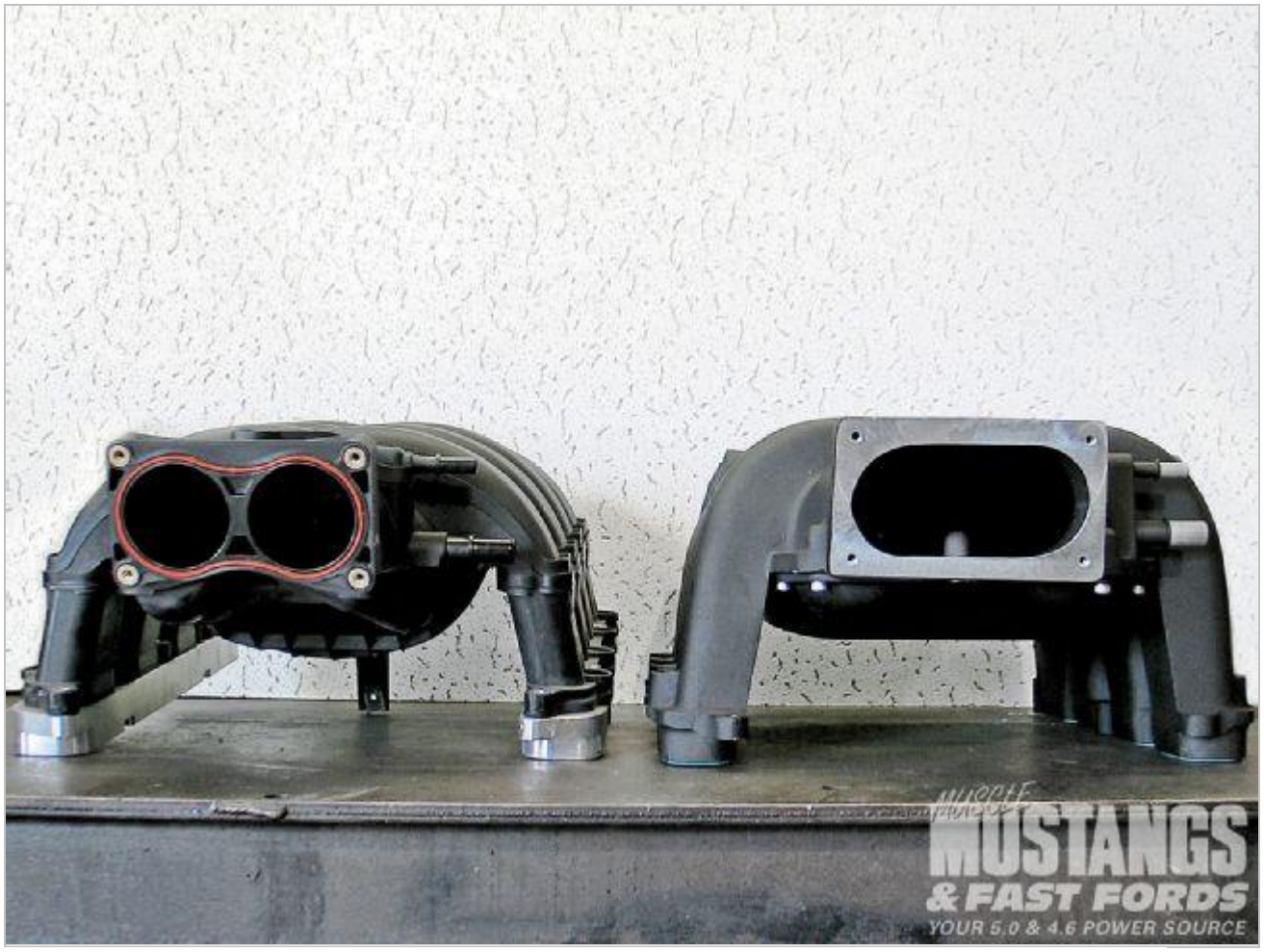
For a suitable test subject, we turned to Hurricane Performance in Orange Park, Florida, which offered up the company's '05 Mustang GT shop vehicle. The Mustang in question is currently at the pinnacle of 4.6L Three-Valve performance with its naturally aspirated 400-plus-rwhp status, and we thought the C&L intake manifold would give it a sizeable kick in the pants over the factory intake manifold. The Mustang features an Al Papitto-built (Boss 330 Racing) 302ci bullet based on a Ford Racing Performance Parts Boss 302 block. Kris Starnes ported and polished the stock heads,

and a pair of Anderson Ford Motorsport prototype camshafts moves the air and fuel through the engine.

Installation of the C&L intake is fairly simple. The only real change between it and the stocker is the length of the bolts that are used. Because C&L has eliminated the charge motion control valves (CMCV) from the intake tract, it uses slightly shorter bolts, which are provided. Total installation time was easily under an hour, and rather than just offering you a simple before and after test, we took the opportunity to run a few tests with different throttle bodies on both the stock and the C&L intake manifold.

With a stock intake manifold, stock throttle body, and the factory charge motion control valves in place, the 5.0L laid down 409.08 rwhp, followed by 410.96 with the CMCV-delete plates. Next we installed a production GT500 throttle body and adapter plate, leaving the CMCV-delete plates on. Peak power increased from 410.96 to 414.65 for a gain of 3.7 hp-though we saw as much as 6 hp at just under 6,600 rpm. Out of curiosity, we reinstalled the stock CMCV plates, and power output decreased to 409.08 and 411.28 on back-to-back pulls. Once the throttle body has been opened up, they do become a restriction.





Next it was the C&L intake manifold's turn, and equipped with the GT500 throttle body, peak power improved to 429 hp. Bender told us that a single-blade throttle body wouldn't disappoint, and it didn't as it increased power output to 435.90. The C&L piece really flows some air, so the better throttle body is needed to make sure it lives up to its potential. While the single was worth some 7 hp at peak power, in other areas under the curve, it was good for as much as 8-9 rwhp.

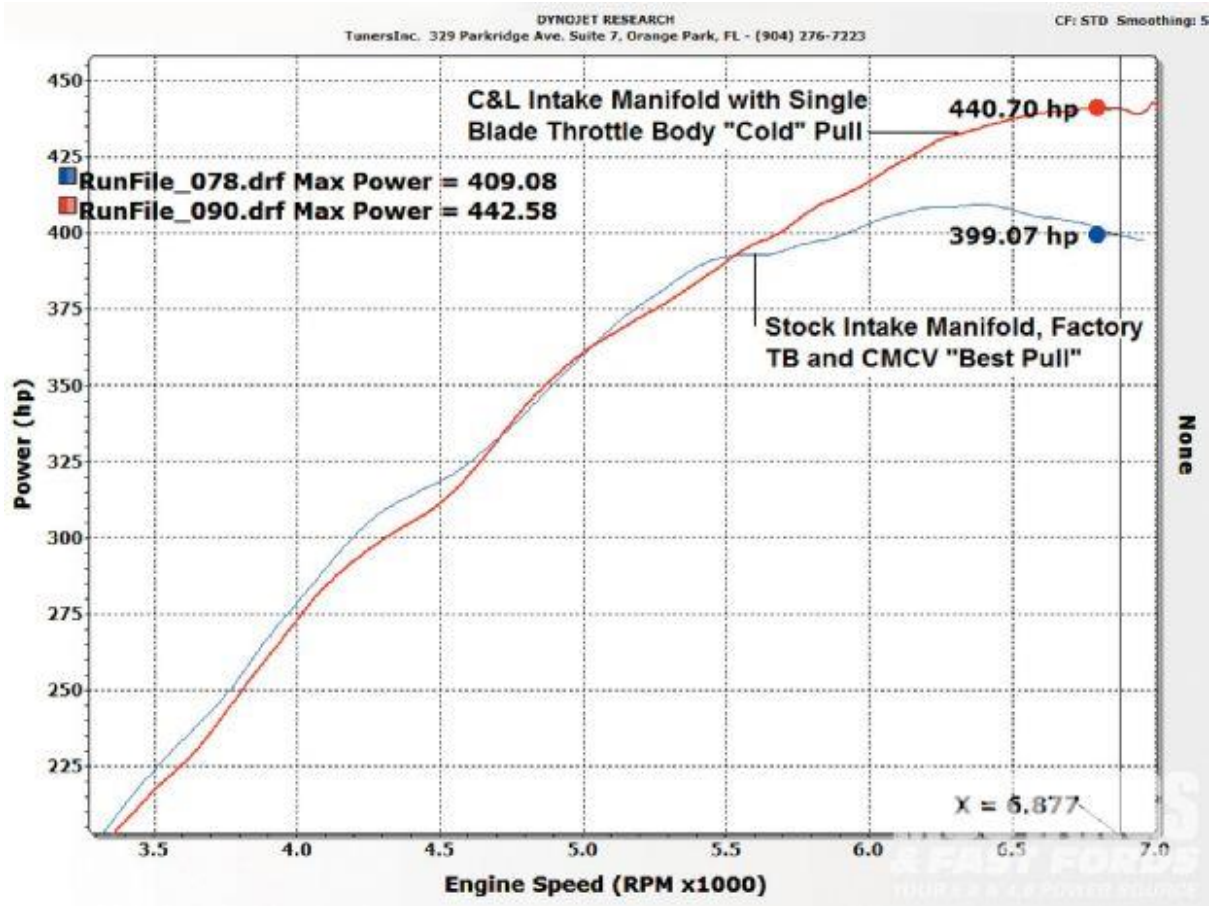
Old drag racing habits die hard, so for the next dyno pull, we gave the engine a 45-minute cool down and iced the intake manifold for about 30 minutes. Horsepower increased from 435.90 to 442.58 at peak, and was up everywhere along the curve as well.

In the end, peak power went from 409.08 to 435.90 hp. The biggest improvement, however, was achieved at 6,875 rpm, where power went from 399.13 to 440.73, a gain of 41.6 hp. Since this test, C&L, Hurricane Performance, and Tuners Inc have swapped out the single-blade throttle body for the Ford Racing Performance Parts twin-bore Cobra Jet throttle body, and horsepower was within one single horse. What's more important is that driveability is much improved, and little to no tuning is required for it. C&L is now recommending the CJ throttle body for all of its manifold buyers.


DYNOJET RESEARCH
TunersInc. 329 Parkridge Ave. Suite 7, Orange Park, FL - (904) 276-7223
CF: STD Smoothing: 5
C&L Intake Manifold with Single Blade Throttle Body "Hot"
RunFile_086.drf Max Power = 435.90
RunFile_084.drf Max Power = 429.24
412.46 hp
403.92 hp
C&L Intake Manifold with GT500 Throttle Body "Hot"
X = 5.998
Power (hp)
Engine Speed (RPM x1000)
None


DYNOJET RESEARCH
TunersInc. 329 Parkridge Ave. Suite 7, Orange Park, FL - (904) 276-7223
CF: STD Smoothing: 5
C&L Intake Manifold and Single Blade Throttle Body "Cool Down"
RunFile_086.drf Max Power = 435.90
RunFile_090.drf Max Power = 442.58
C&L Intake Manifold and Single Blade Throttle Body "Hot"
Power (hp)
Engine Speed (RPM x1000)
None

Further cementing the C&L intake manifold's impressive gains is the fact that NMRA Real Street competitor Tim Matherly will be running the intake manifold this year on his new Three-Valve combination, and S.D. Wheeler will be using one as well on his NMRA Super Stang entry as well. We expect to see even more out there now, considering C&L says it has sold its entire first run of manifolds already.

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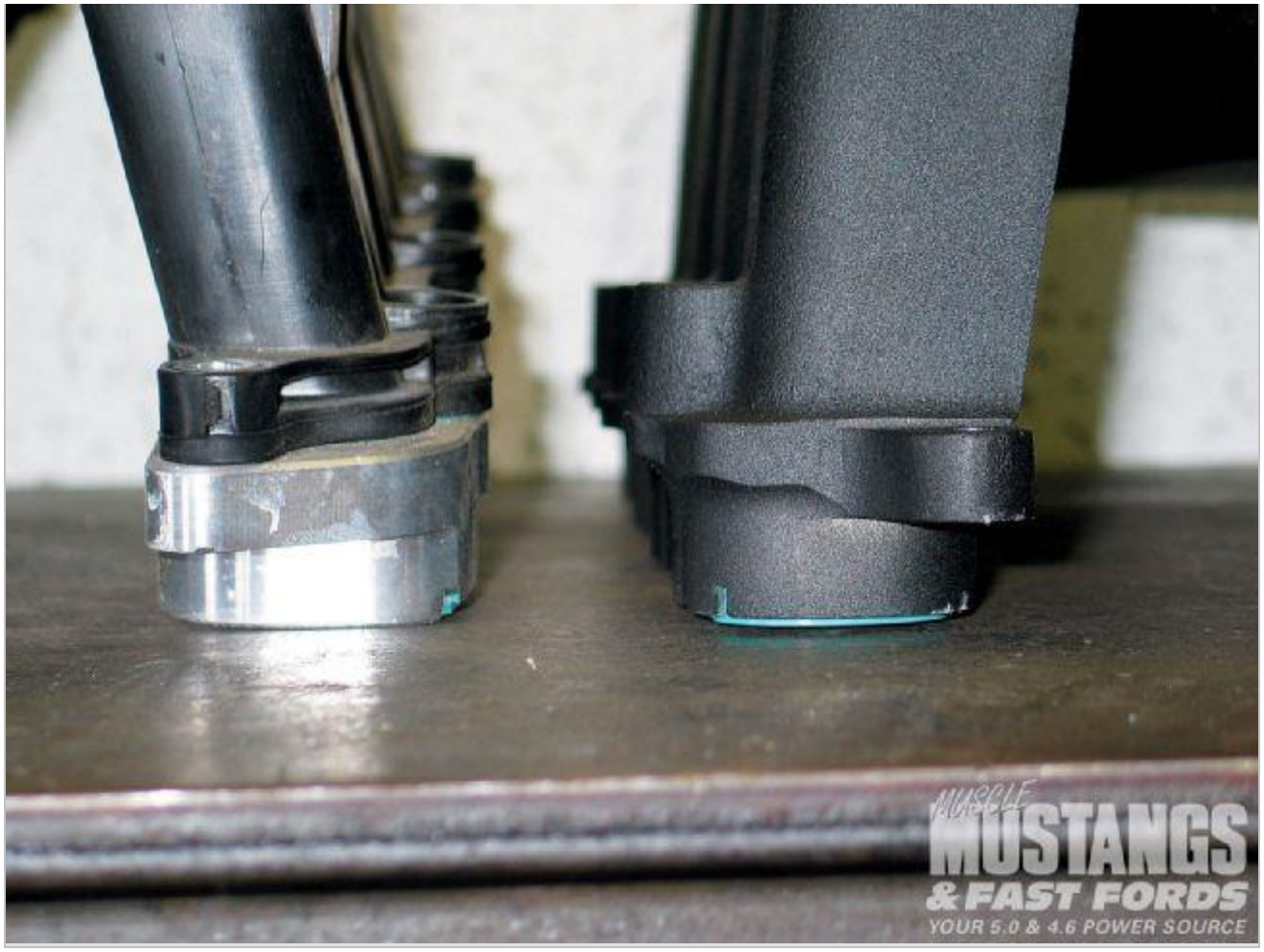
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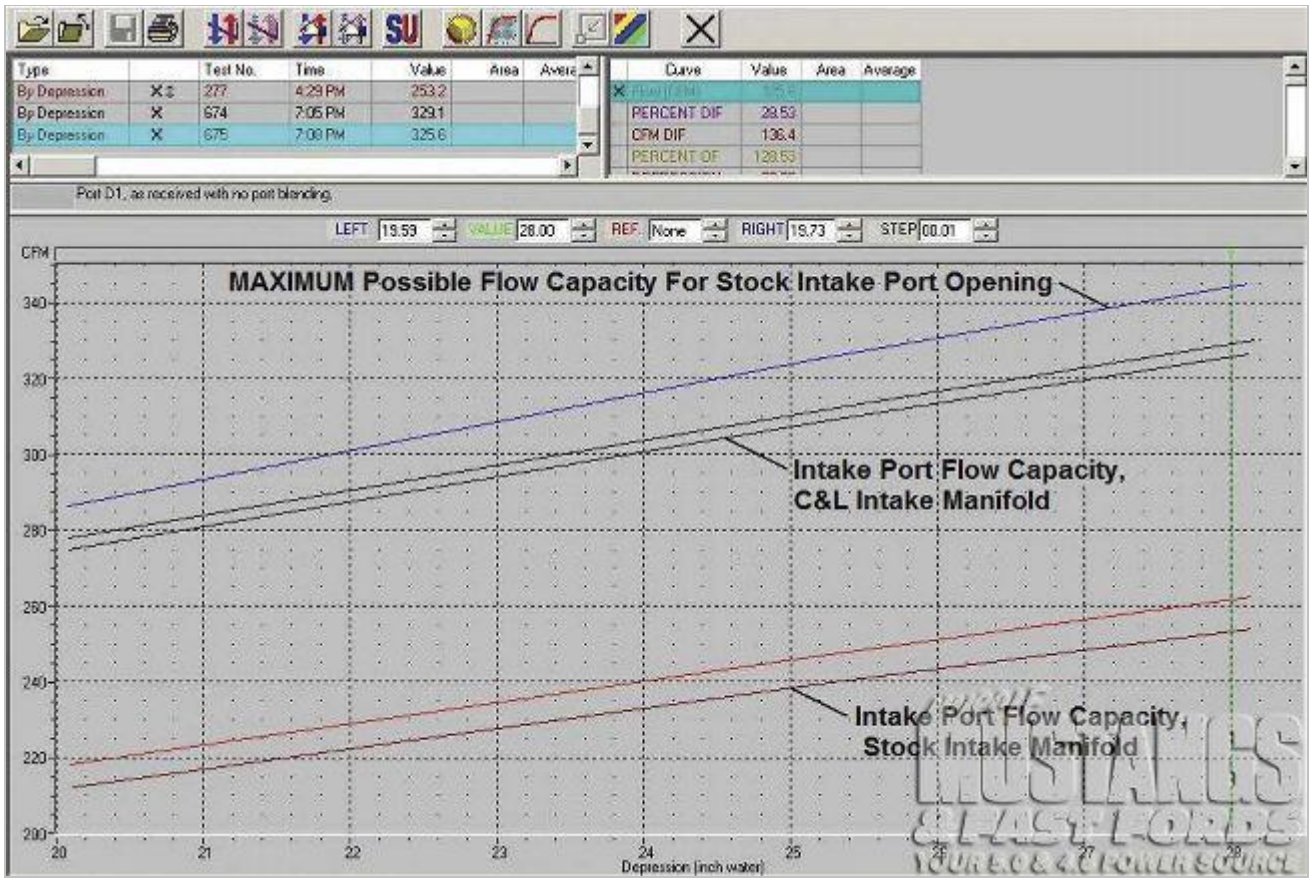
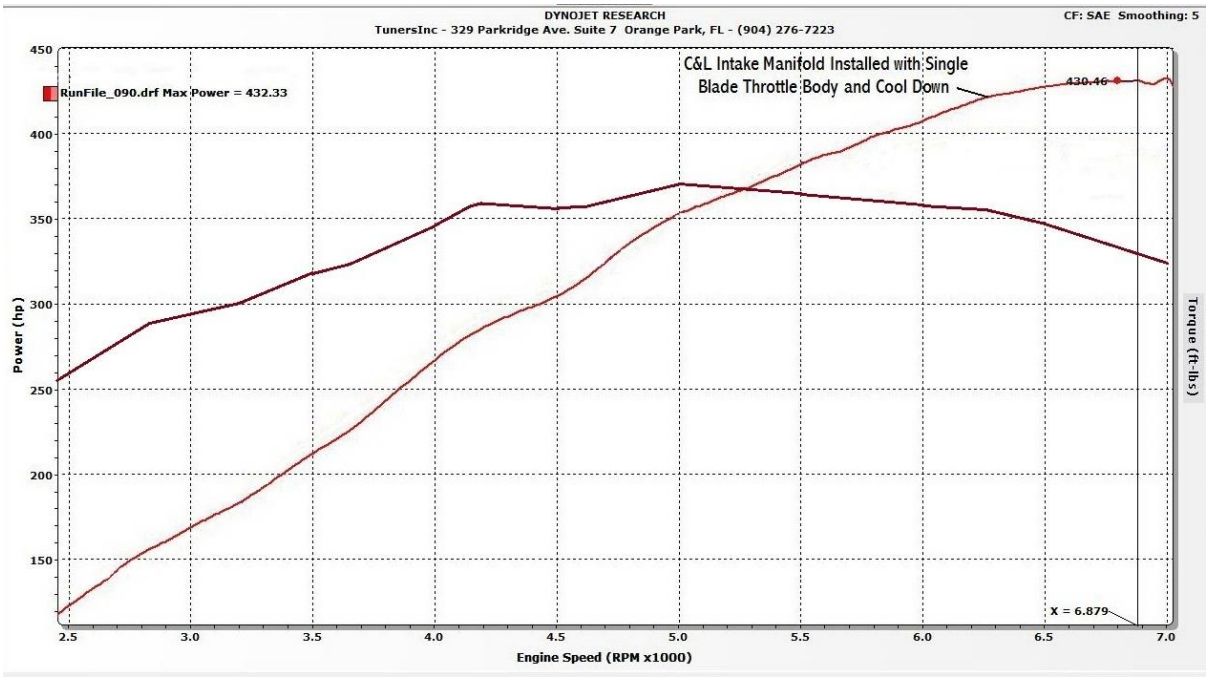
Go With The Flow

C&L Performance's Lee Bender offered us this flow chart from his testing that shows the flow capacity differences in CFM between the original factory intake manifold and the new C&L Intake. The red lines show two different runners on the factory intake, while the black lines show both a single driver's side and single passenger's side runner on the C&L manifold. The blue line shows the maximum possible amount of airflow that can be passed through the size and shape of the stock intake port opening. "You can see that the variation between the two C&L ports is much smaller than the original factory intake," says Bender. "This is because all ports on each respective side of the intake are identical, and this delivers a superior runner flow balance as compared to the original stock intake manifold."



Hurricane's Three-Valve project car, an '06 GT owned by Hurricane Performance co-owner Josh Klugger, was the subject of previous MM&FF tech stories, including the aforementioned C&L intake and N-73 cams. With the current combination, the GT has been consistently laying down 11.50s in the quarter-mile at 118 mph. In the eighth-mile, which is how it usually competes, the coupe has been as quick as 7.40s at 93 mph.



One major supplier of performance camshafts is Anderson Ford Motorsport (AFM). Rick Anderson is always on the leading edge of camshaft technology, and has been concentrating his efforts on a new Three-Valve cam profile-the N-93 (PN AF-N93; $749 per pair). It offers 0.492-inch lift on the intake with 240 degrees of duration at 0.050-inch, and 0.492-inch lift on the exhaust and 252 degrees of duration at 0.050-inch. Its predecessor, the N-73, features 0.492-inch lift on the intake with 232 degrees of duration at 0.050-inch, and 0.492-inch lift on the exhaust with 244 degrees of duration at 0.050-inch.

"We tightened them up a bit," said Rick Anderson when asked about the difference. Anderson is known for his cam profiles, and for good reason. AFM cams are highly sought after in the Mustang world, and Anderson puts in long hours, painstakingly varying cam profiles until he gets the desired results. The real difference is in the lobe separation-110 degrees over 108 degrees on the N-73s.

Camshafts in hand, we headed to Hurricane for some thrashing. Since the car had just returned from a race, we had some good baseline track numbers. And since we were just a day away from our track day at Gainesville Raceway, we had to rush. For a fair baseline, Tony Gonyon of TunersInc (Orange Park, Florida) strapped the coupe to the Dynojet, making small adjustments to the tune to maximize output of the N-73s. The results were 412 rwhp and 357 lb-ft of torque.

The next morning, Combs removed the cam covers on the Three-Valve and began the swap. A couple of hours later, he was putting on the finishing touches. When Gonyon hit the key, the Three-Valve came to life. I couldn't believe how aggressive it sounded.

So before we made the first pull on the Dynojet, I gave Rick Anderson a call. When I told him how nasty the cams sounded, he replied with a chuckle. "Yeah, we tried a few different profiles before we chose this one," Anderson said. "That's what we were going for."

Gonyon made a few partial pulls, monitoring the air/fuel ratio. Everything looked good, so he made a full pull. The results were 422 rwhp and 360 lb-ft of torque-a 12hp and 3-lb-ft increase at peak. More importantly, though, was the 10-lb-ft increase in torque from 5,900 rpm to redline.

Gonyon then made some adjustments to the tune, to see if an increase or decrease in either fuel or spark would work better with the new cam profile. After a few pulls, it was clear that the previous tune was ideal, with one exception. "It likes a little more timing on the low end," said Gonyon-two degrees, to be exact. After a long cool-down period, Gonyon made one last pull on the dyno. The results were 428 rwhp and 362 lb-ft of torque-a 16hp and 5-lb-ft difference.

The next day, we hit the track at Gainesville Raceway. A few runs with Gonyon behind the wheel yielded equivalent to what it had run before-high-11.40s at 118 mph. Gonyon began looking at the data being logged by his laptop, and realized we were missing something. The power band had been moved up, requiring him to shift later.

After icing down the intake (it was almost 90 degrees out, and even hotter on track), Gonyon rolled back to the starting line and waited for the tree. The results were impressive: 11.38 at 120 mph. "Instead of shifting at 7,200 rpm like before, I shifted at 7,500. Looking at the data log, rpm only dropped to 5,200, allowing us to stay in the power band and get down the track quicker," Gonyon said. The 60-ft time was equivalent to before-1.56.