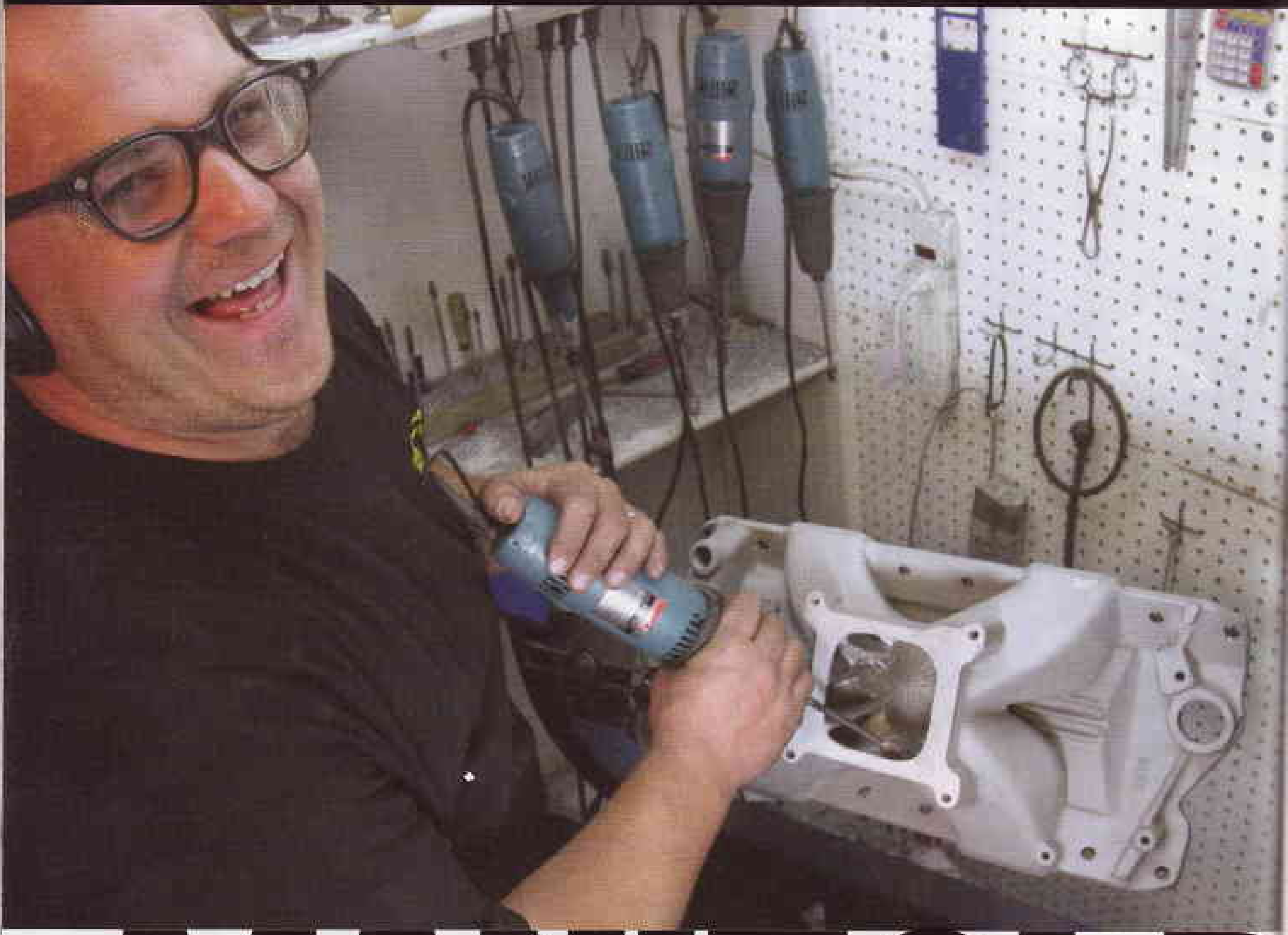


THE MANIFOLD MAN

Before and After Effects of Porting Three Different Intake Manifolds.

By Steve Dulcich

Photography: Steve Dulcich

Since the days of relieving flathead Fords, we've known about the advantage of porting. Grind those critical passages with the right touch, and airflow through the engine improves—and with more air comes more horsepower. There was a time when a set of ported heads was considered exotic, the realm of high-end race power. Back then, a set of nicely ported heads on a street machine was enough to have a leg up on the vast majority of regular Joes with their typical street brawler or Saturday night race cars. Times have changed. With the explosion in aftermarket cylinder heads and easy CNC porting, these days it seems like any serious engine build will include a set of ported heads. Does that mean the job is done? Not according to Bryce "Manifold Man" Mulvey of Dr. J's Performance.

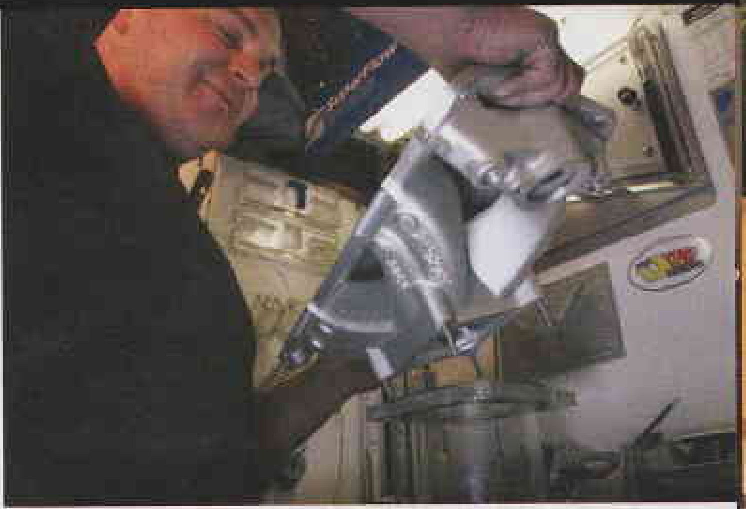
Consider the complete engine as a flow system, and it becomes clear that the pathway does not begin and end at the cylinder head. Bolt an intake manifold to a fully prepped cylinder head, and the two become one as far as airflow is concerned. Guys tend to take it for granted that most any aftermarket intake manifold will be more than up for the job, and it can be—but not always. Sometimes the intake flow is not even close, and in most cases there is room for improvement, especially in high-powered applications where the heads are set to kill. Here is where Manifold Man Mulvey persuasively argues that custom manifold work can up the power ante. We asked him to put his manifolds where his mouth is and show us the numbers, and he did, convincingly.

RAW FLOW

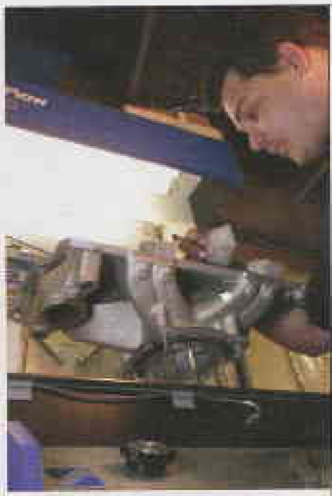
Very few performance shops flow-test intake manifolds, primarily because the setup can be awkward and time-consuming. To simplify things, Dr. J's manufactures flow adapters that make this a quick and easy procedure; they're available for mounting 4150, 4500, and spread bore intakes on a SuperFlow bench. The arrangement sets the manifold up in a blow-through configuration, allowing each port in an intake manifold to be tested in rapid succession. While some perceive this flow procedure with misgivings, intuiting that the flow bench is blowing into the manifold while the engine sucks, from the standpoint of airflow volume the only thing that matters is the pressure differential across the manifold. The bench and the intake manifold runners don't care which side of the flow system is providing the force creating the pressure differential.

Flow-testing intakes on the Dr. J's adapter sets the manifold upside down on the bench, allowing seven of the eight runners to be blocked to isolate any individual runner for flow evaluation. The configuration also allows easy access to the runner for velocity probing, greatly aiding in the development process in search of improved flow. Mulvey points out that the manifold adapters are designed with four radiused-entry orifices that mimic the placement of the throttle bores on the corresponding carburetor configuration, thus simulating the airflow entering the manifold with a carburetor. The placement of the throttle bores has an influence on the airflow into the plenum, as well as runner-to-runner airflow distribution.

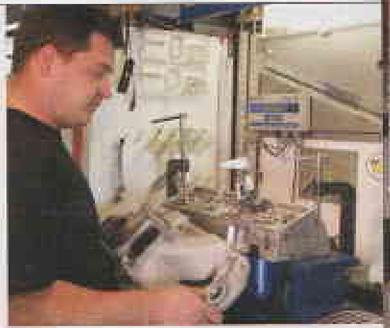
So what do the numbers show? We spent the afternoon at Dr. J's and tested some of the most popular Edelbrock intakes for the small-block Chevrolet, flowing both the as-cast intakes as well as one that had received the full porting treatment. Up for evaluation were Edelbrock's Performer RPM Air-Gap, the Victor Jr., and the Super Victor. The accompanying manifold flow chart shows our resulting numbers. As can be seen, there is substantial room for flow improvements with the full porting treatment, bringing the manifolds' raw flow in line with the capacity of high-end cylinder heads.



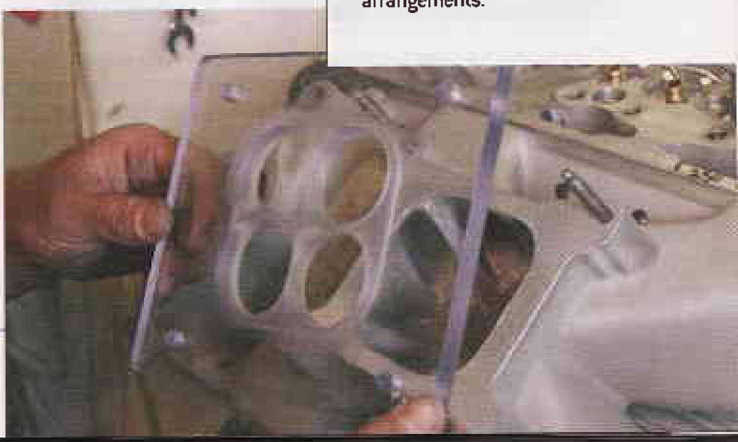
> Using a Dr. J's adapter and blowing into the plenum, Manifold Man Bryce Mulvey prepares to test an Edelbrock Super Victor intake. The flow adapter simulates the throttle bores of a 4150 carb.



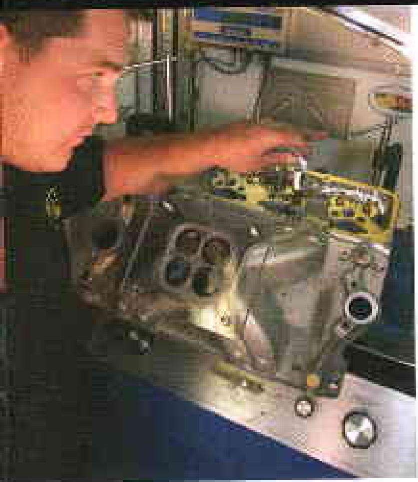
> Using seven foam plugs cut to fit the runner exits, Mulvey can quickly seal off the ports not being tested to isolate the test port. With this technique, all eight runners of the manifold can be rapidly tested to evaluate port flow and the effectiveness of modifications. Mulvey points out that with this configuration, the runners are readily accessible for velocity probe testing.



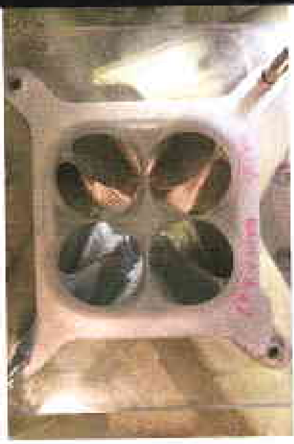
> To gain further insight into the airflow, all six of our manifolds were tested in conjunction with the cylinder head. In all cases, the porting improved the airflow of the head/manifold combination.



> A radiused entry plate with four bores is used to simulate the airflow path at the plenum entry of a four-barrel carburetor. The ideal form of the radius entry negates the effects of a carburetor's restriction. Dr. J's has radius plates and flow adapters to simulate all of the popular four-barrel carb arrangements.



> Flow-bench testing with the manifold mounted to the head is a time-consuming and arduous process, especially if all eight runners are going to be flowed. Mulvey spot-checked our six test manifolds at peak intake port flow, which equated to 0.750-inch valve lift, testing the No. 6 runner only.



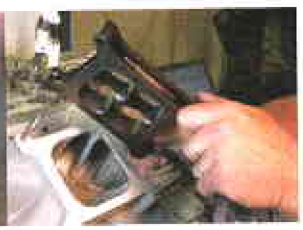
> Full manifold porting includes reworking the plenum, streamlining and resizing the runners, and port-matching the exit to the cylinder head. Dr. J's developed its plenum form to optimize flow while using wet-flow evaluation to minimize fuel separation. Note the symmetry of the runner entrances when viewed through the 4150 radius plate.

MANIFOLD FLOW CHART

INTAKE	RPM Air-Gap		Victor Jr.		Super Victor	
	Cast	Ported	Cast	Ported	Cast	Ported
RUNNER						
1	214	288	241	295	300	345
2	224	308	243	302	293	351
3	221	312	241	286	276	341
4	208	282	243	301	271	357
5	218	304	250	305	277	352
6	213	288	230	287	277	341
7	210	286	246	300	290	355
8	220	306	235	299	295	346

Note: Compares bare manifold flow in as-cast form to Dr. J's porting. Includes full plenum porting, runner streamlining/resizing, and gasket match to Fel-Pro No. 1206 gasket.

> Dr. J's prefers a radiused form at the tops of the runner entrances as opposed to a sharp edge or the eyebrow, as shown here, commonly found on most as-cast intake manifolds.



> In numerous dyno tests we have found that a tapered spacer such as this Wilson unit adds power. While the bench was running, Mulvey stacked one under the radius plate on the ported Victor Jr. and saw the flow jump about 4 cfm.

HEAD/MANIFOLD COMBO

While raw numbers are a good development tool for the manifold and cylinder heads in isolation, testing each alone leaves out the context of the combined manifold/head flow path. A look at the collective flow of the intake and cylinder head offers further clues relative to the potential performance gains. Of course we needed a set of cylinder heads to test with, and we reasoned that high-flowing heads would offer more of a challenge to the manifolds' capacity than a lesser pair. Mulvey fully ported a well-used set of AFR 210 cylinder heads, creating the airflow values recorded in our cylinder-head flow chart. These are strong numbers for a 23-degree Chevy cylinder head, and as the data shows, the peak intake flow is in excess of the as-cast capacity of the manifolds.

In testing as a combination, we found some interesting effects. To abridge the procedure, all of the intakes were tested only on the No. 6 runner and at the cylinder head's peak airflow valve lift of 0.750 inch. Interestingly, we did not find a direct correlation between the individual flow of the components and the overall flow of the intake/cylinder-head combination. The as-cast RPM and Victor Jr. tested individually flowed far less than the intake port, while the combined flow showed that the cylinder head enhanced airflow through the manifold. Clearly the manifold losses were reduced with an increase in intake flow capacity, as illustrated by the significant gains in combined flow with the fully ported intakes. The real question was how this would relate to power production. It was time to hit the dyno to find out.

POWER NUMBERS

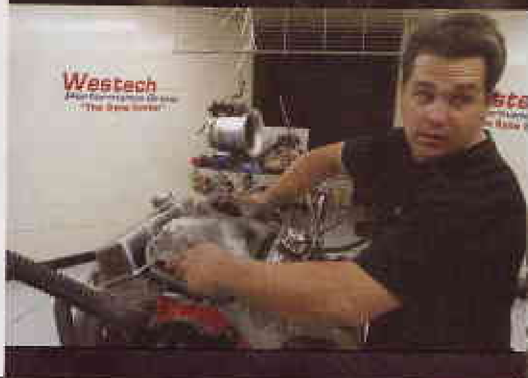
Testing manifolds requires an engine with enough draw on airflow demand to make a difference. Take a 400-horse or lesser motor, and you can run the gambit of manifolds and potentially see very little change to the power curve to distinguish intakes of the same basic configuration. The word to key on here is configuration, since airflow is far from the sole determining factor in power output. Variables like port shape, runner taper, cross-sectional area, and runner length will all influence the power curve; however, within a given intake configuration, more airflow is normally going to be better, particularly if the entire engine combination can utilize the additional air.

Our test engine was a 410ci piece with sufficient capacity to tax the induction system. Based upon a production 400 block, the engine was built by Mike Morgan using the same Dr. J's ported AFR 210 cylinder heads we used for our airflow evaluation. The engine was expected to produce about 600 hp. At that power level, we'd likely see the influence of the ported intakes on overall power output, particularly at higher rpm, when airflow demand is at its greatest. Our testing included the same manifolds as tested in our airflow evaluation, in as-cast and ported form. The outcome is shown in the dyno results table.

It was surprising to see how well the dual-plane RPM Air-Gap intake performed at this power and rpm level. We noted the expected torque gains with this intake configuration, as seen by the strong low-end numbers. Ported, the Air-Gap gained in high-rpm power, putting it in the league of the stock single-plane manifolds in top-end horsepower, cracking the 600hp barrier. While the lower end of the rpm range seemed to lose some ground with the ported dual-plane, the overall torque numbers were still much stronger than those of any single-plane manifolds. Strong even in stock form, for an all-around intake, the ported RPM Air-Gap is hard to beat.

Looking at the single-plane manifold results, the power gains came into play at a lower rpm range than with the

> **Above:** Flow testing is certainly valuable, but as always the bottom line is power output. A hot 410-cube small-block Chevy would serve as our testbed to compare the intakes.
> **Right:** With six intakes to test and little more than an afternoon to do it after setting the engine up on the dyno and breaking it in for a baseline, we were appreciative of Mulvey's hustle on the parts changing. Here the stock Victor Jr. is removed to make way for the ported version, which was worth 14 extra horsepower peak to peak.



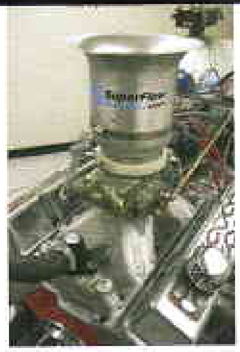
> **Left:** The Super Victor seemed to be the ideal intake for this engine combination, making more power as-cast throughout the curve than the Victor Jr., and the most peak power of the as-cast manifolds. We had to wonder how much room to the upside remained, given the strong as-cast performance. Mulvey swung his ported Super Victor in place, and we found a sizzling 615 hp for a 13hp gain in peak output. With this ported intake the power curve showed strong numbers throughout the rpm range tested.

> **Above:** Testing the two-plane Performer RPM Air-Gap showed more modest gains in peak output, with porting providing a 6hp improvement peak to peak. The ported Air-Gap definitely favored the higher end of the curve, showing as much as a 13hp advantage at 7,000 rpm. Both as-cast and ported, the Air-Gap held a significant torque advantage over the single-plane intakes through the midrange, with the ported Air-Gap producing max power numbers on par with the as-cast single-plane manifolds.

dual-planes. The Victor Jr. picked up a remarkable 14 hp peak to peak with porting. The significant gain suggests that the engine was hungry for the added airflow. While the results with the Victor Jr. were predictable based upon the large gains in raw manifold flow on the bench and the highest combined flow gain for a head/manifold combo, the Super Victor results were startling.

We would have expected the Super Victor to be handicapped at the lower end of the rpm range compared to the Victor Jr., but the numbers proved otherwise. In both stock and ported form the Super Victor showed superior numbers compared to its little brother, making it a better choice on our engine combination. With porting, the total flow of the ported Super Victor was higher than with any other manifold, and our best guess was that this manifold would be the horsepower leader. That said, since the as-cast airflow was also much higher than the other manifolds, we had to wonder whether the porting would show as much benefit as it had with the Victor Jr. The dyno told the story here, showing a peak-to-peak gain of 13 hp, very close to the improvement in top-end output seen with the Victor Jr.

Our testing left little to the imagination when considering the possible benefits with manifold porting. Squeezing an extra 13-14 hp from this type of engine combination isn't an easy task, and few would have guessed we would have found it by taking a carbide bit to these already excellent intake manifolds. **HRM**



We could guess that ultimately the improvements in power were the result of a more efficient flow system through the engine, which causes the engine to take in more air and make more power. To gauge the changes in actual airflow, a SuperFlow air turbine was mounted to our Holley test carburetor. The airflow numbers give us just that much more information on the effects leading to increases in power. We think the results are essentially self-explanatory—namely, the power increases came hand in hand with greater airflow through the engine.

AIR CONSUMPTION RESULTS

SuperFlow air-turbine
Recorded CFM air consumption

	Recorded Air Consumption CFM @ 7,000 rpm	
Manifold	As-Cast	Ported
Air-Gap	728	743
Victor Jr.	750	772
Super Victor	769	783

DYNO RESULTS

410 small-block Chevrolet
SuperFlow 901 engine dyno
Tested at Westech Performance Group

HORSEPOWER

	RPM Air-Gap		Victor Jr.		Super Victor	
RPM	Cast	Ported	Cast	Ported	Cast	Ported
3,600	347	343	332	329	333	329
3,800	383	378	364	358	366	366
4,000	416	411	394	390	395	394
4,200	443	438	422	419	422	420
4,400	466	462	448	444	448	448
4,600	487	483	471	468	470	471
4,800	507	503	493	492	493	493
5,000	524	521	520	517	517	519
5,200	543	540	538	540	539	542
5,400	558	557	555	560	554	561
5,600	571	569	568	576	571	576
5,800	582	581	577	582	581	586
6,000	589	586	588	589	590	595
6,200	591	595	594	598	600	605
6,400	594	600	598	604	601	608
6,600	592	600	597	613	602	613
6,800	583	592	599	511	600	615
7,000	572	585	588	609	592	611

Dr. J's isn't exclusively a manifold shop, but it applies the same science to custom cylinder-head port work. The heads for our test engine are an ancient set of AFR 210s, which according to Mulvey were pretty much "used up" when they came in. A detailed custom porting job produced the flow shown in the chart below.

CYLINDER HEAD FLOW CHART

AFR 210
Ported by Dr. J's
CFM Port Flow @ 28 inches water
SuperFlow 600 Bench

	Intake	Exhaust
Lift		
0.100	72	58
0.200	145	113
0.300	194	152
0.400	242	198
0.500	272	225
0.600	289	240
0.700	298	247
0.750	301	251

HEAD/MANIFOLD COMBINATION AIRFLOW CHART

Ported AFR 210 head/various manifolds
CFM @ 28 inches water
SuperFlow 600 Bench
Runner No. 6 @ 0.750-inch valve lift

Intake	CFM As-Cast	CFM Ported	Difference
Performer RPM Air-Gap	251	267	+16 CFM
Victor Jr.	247	276	+29 CFM
Super Victor	258	282	+24 CFM