# Nine Degrees Of Separation

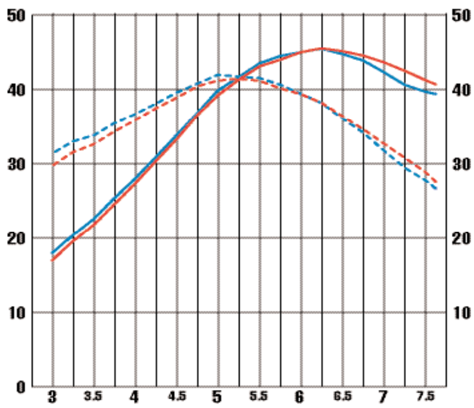
As the saying goes, "In theory, there's no difference between theory and practice, but in practice, there is." How true.

As part of our DR650 Blueprinting project, which concludes in this issue, we decided, at the last minute, to find out just how much difference cam timing really makes to our engine's performance.

Theory will tell you that the vast majority of production engines are designed with what's called "split overlap" which is when the intake valve opens the same number of degrees before top dead center (TDC) that the exhaust valve closes after TDC. The theory holds that by doing it this way, the intake valve gets off its seat early so that exhaust gasses rapidly exiting the combustion chamber will pull the intake charge into action before the descending piston creates its own suction, which causes the maximum amount of intake charge to flow into the cylinder, raising volumetric efficiency and power. This effect also allows the early-incoming fresh fuel-air mixture to displace the last of the burnt mixture, in effect scavenging the combustion chamber of non-combustible gasses that, if ingested, would only encourage detonation.

This was the reasoning behind our choice of cam timing for the Blueprinting project. Part One of the series revealed that Suzuki's stock timing showed a 4° retard from split overlap. Experts will tell us that retarded timing can sometimes improve peak power, but often doesn't. Clearly, the stock camshaft's timing alignment marks indicated that this situation was probably deliberate, not an aberration caused by faulty machining, although we couldn't be absolutely sure and Suzuki wasn't saying. We were left to speculate that perhaps this slightly odd cam timing was intended to compensate for the motor's relatively restrictive stock muffler and intake system, which in our case had been replaced by freer-flowing items.

Our milling cuts, meant to optimize the turbulence enhancing effect of the combustion chamber's quench surfaces and also raise the compression ratio for premium fuel, had decreased the distance between the crankshaft and camshaft sprockets by 1.5mm. This created an additional cam retard of 4.6° at the crankshaft, so we calculated how to correct for both factors to achieve split overlap. As you follow the article beginning on page 26, you'll see how we did it, eventually moving the cam from 8.6° of retard to 1° of advance—9.6° total.




**Blueprinted DR650SE**

*SAE Corrected Horsepower*

| RPM | +1° Advance | -8.6° Retard |
|---|---|---|
| 2750 | 15.91 | 13.09 |
| 3000 | 17.92 | 16.97 |
| 3250 | 20.43 | 19.57 |
| 3500 | 22.53 | 21.73 |
| 3750 | 25.29 | 24.51 |
| 4000 | 27.92 | 27.29 |
| 4250 | 30.79 | 30.30 |
| 4500 | 33.88 | 33.33 |
| 4750 | 36.85 | 36.58 |
| 5000 | 39.85 | 39.21 |
| 5250 | 41.69 | 41.27 |
| 5500 | 43.52 | 43.12 |
| 5750 | 44.50 | 43.97 |
| 6000 | 45.01 | 45.01 |
| 6250 | 45.47 | 45.52 |
| 6500 | 44.75 | 45.14 |
| 6750 | 43.90 | 44.57 |
| 7000 | 42.37 | 43.66 |
| 7250 | 40.63 | 42.55 |
| 7500 | 39.70 | 41.29 |
| 7750 | 39.39 | 40.69 |

Other things happen when you move cam timing events by such an amount. With a single overhead cam engine, all the openings and closings are either moved forward or back together. And perhaps the most significant of these is the intake closing, for two reasons. One is that the intake closing creates the engine's favored rpm range. An early closing favors lower rpm and later favors higher rpm. The reason being that intake closing is always delayed well beyond the start of the piston's upward compression stroke to take advantage of the inertia of the incoming fuel-air mixture, which rises with rpm. The second reason is that intake closing is when actual compression begins. Although the DR650's cam timing is pretty tame, as it's a dual-sport bike that needs plenty of grunt for off-road work, a 9.6° timing difference should make a major difference to the power curve.

Another rule of thumb is that moving the cam 1° will shift the torque peak about 100 rpm. If that were the case, our 9.6° shift would create a massive displacement of nearly 1000 rpm. So, what we should have expected when we reset the camshaft to its original dowel pin location, with additional retard coming from the milling, was at best a significant loss of power at bottom end of the rpm range, with possibly a big increase on top…at best.

That was the theory. In practice, what we got, once the carburetion was dialed in, was not nearly so dramatic. In fact, as the accompanying dyno charts show, the "retarded" timing lost an average of 1 hp below 6000 rpm and gained a little past that point, with a solid 1.9 hp edge at 7250 rpm. So, if the effort to adjust the cam timing looks tedious, and particularly if the bike is intended to be ridden as a supermoto, it's really not that necessary.

While we will continue to ride the bike with its timing corrected, and we can definitely notice some additional oomph down low, where it will come in handy during trail riding, the big difference we expected was hardly big at all.

As far as the DR650SE is concerned, theory and practice really are two different things.

With all that we've learned, we're inspired to calculate improved camshaft lift and timing and try a new cam next.

Cheers!

*—Dave Searle*
*Editor*