

Practical men

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WHEN YOU HIT YOUR BIKE'S STARTER button, odds are that for every cylinder you summon to life, there are four valves, opening and closing in half-time. Yes, there are some interesting exceptions, but four valves per cylinder is the majority choice for new motorcycle and auto engine designs in the current era.

Three main traditions exist. In production auto engines, longish strokes prevail as a means of obtaining fast-burn, low-emissions combustion chambers. Bore/stroke ratios hover at the 1.0-0.9 level. In Formula One auto-racing engines, dimensions have gone berserk in the search for higher revs and valve area to make them possible. Bore/stroke ratio is now 1.8 and climbing. Steering a middle course are modern four-valve motorcycle engines, with bore/stroke ratios close to 1.5. Less saddled with emissions laws, and requiring the benefits of short strokes, motorcycle engines combine practicality and sporting qualities.

The four-valve arrangement is old, dating back to before World War I. Out of the great variety of ideas being tried in that exciting, protean time, one arrangement came forth to prevail. It was four valves per cylinder, operated by dual overhead camshafts, with a central sparkplug. This concept was created for reasons different from those that have carried it into the present. Then, the bigger the valve, the more likely it was to warp and crack. Two small exhaust valves lasted longer than a single bigger one. The less mass a valve spring had to control, the less likely it was to break. That made direct valve operation by overhead cam, without pushrods or other intermediate machinery, the best bet for reliability. In that time, huge strokes, twice the bore diameter, were the vogue, and it was hard to fill such long cylinders through only two valves. Using four gave an advantage. In a time when fuel-octane numbers were probably in the 35-50 range, a central sparkplug gave at least some chance that the charge might burn before it could detonate and wreck the engine.

This concept was not the work of graduate engineers. It was, as one historian has put it, created by "three drivers and a draftsman." The three racing drivers, Paolo Zuccarelli, Jules Goux and Georges Boillot, thought about what had worked and what had not, and believed they could do better. History



shows that it is often this way with innovation; while educated folk are most comfortable with established truth, practical men, who don't know that their ideas cannot work, strike out in new directions. The three were assisted by Ernest Henry, draftsman.

Robert Peugeot, the auto maker, backed them. Their new racing car, combining many ideas previously tried separately by others, was a crushing success in 1913. It was instantly bought, circulated, copied and elaborated upon by everyone. One such car came to the U.S., was wrecked, then reconstructed by Harry Miller, whose Miller race cars would have such long, strong influence upon American racing.

Another practical man was Charles B. Kirkham, an associate of motorcycle pioneer turned aviation magnate Glen Curtiss. When given the mandate to develop a superior engine for fighter aircraft in 1916, Kirkham made the four-valve dohc concept a part of his epoch-making V-12 design. Its reverberations were complex, but one clearly traceable result was the Rolls-Royce Merlin V-12, which powered the Hurricanes and Spitfires that won the Battle of Britain in 1940.

In the post-WWII era, racing-engine design was strongly influenced by successful two-valve motorcycle engines, notably the dohc Norton Manx Single. With careful airflow development, and intake and exhaust tuning, the resulting two-valve design tradition of the 1950s eclipsed the four-valvers for a time. Better spring and valve materials likewise erased some of the reasons for

four valves' initial superiority.

Then came Honda, with a fresh reason to need four valves: the desire to make power at extreme rpm. Honda's first 250cc four-cylinder race engines had two valves, but valve and spring problems were chronic. In this period (late 1950s) two-valve bike engines like the MV Four had very narrow safety margins—as little as 300 revs beyond peak power would bounce the valves. While Mercedes and Ducati's Dr. Taglioni experimented with desmodromic valves, Mr. Honda engineered around the valve-bounce problem by dusting off the four-valve dohc concept. Yes, maybe his engines didn't flow quite as much air as the best two-valvers, but they revved rings around them and won countless GP wins.

Next, four valves were again adopted by auto-racing engines as they, too, reached for higher rpm. Early designs made no more power than their two-valve predecessors, but Cosworth designer Keith Duckworth found a way to speed combustion in big-bore, short-stroke four-valve chambers, and created the very influential DFV V-Eight of 1967. It was still winning races decades later. His contribution was to narrow the valve angle, allowing use of an almost-flat piston. With the right intake downdraft, this simple combustion chamber supported a strong "tumble-charge" motion, leading to fast, efficient combustion.

Honda brought four valves to street motorcycles with its 750F motor, a mid-1970s derivative of an endurance-racing engine, and shortly their use became dominant in high-performance production motorcycle engines, whether Japanese, British, German or Italian. Again, a fresh set of requirements gave the old concept new value. The ability of four small valves to follow an abrupt cam contour allows designers to combine high valve lift with short valve timing. The result—high-rpm power with a wide torque characteristic—was next to impossible to achieve with two valves. It was ideal for streetbikes. It still is.

Most recently, auto makers have adopted four-valve dohc for yet another new reason: The central plug and narrow-valve-angle open chamber can reduce emissions, yet still result in engines capable of spirited performance.

Pretty impressive chain of events to have been started by three drivers and a draftsman. □