BY DAVE COLEMAN

Davec@mcmullenargus.com

Below the Curve

From time to time, if you read the various pontifications of our staff of engineering nerds, you will hear us refer to how widget A improved the area under the curve more than framus B. Area under the curve? Unless your mind is a graph, the area under the curve is probably little more than the place where your grades used to land. In reality, "the area under the curve" is engineering shorthand for "trust me, it's better this way in the long run."

We, the collective of car geeks, tend to get entirely too wrapped up in peak numbers, especially horsepower. Then the debates start. "Peak torque is more important than peak power." "Peak power is more important than peak torque." The battle rages, people get stupid and more precious Internet bandwidth is wasted arguing one misconception against another. The truth, as usual, is that the engine with the most area under the curve, either the horsepower or torque curve, is the one that will be faster.

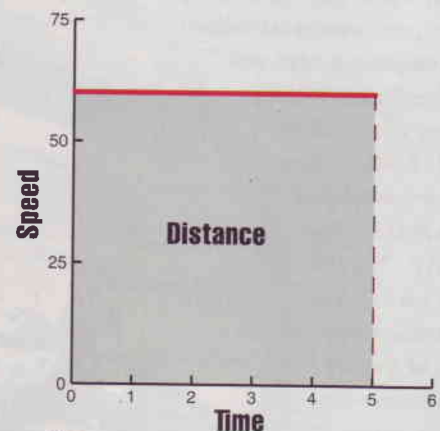
Let's take a step back to see why this is. If you plot anything out on a standard x/y graph (that's Cartesian coordinates, for those of you who like old, stuffy, European sounding names for your graphs), the area under that plot will be the sum of whatever your x-axis is times whatever your y-axis is. That doesn't make any sense at all, does it?

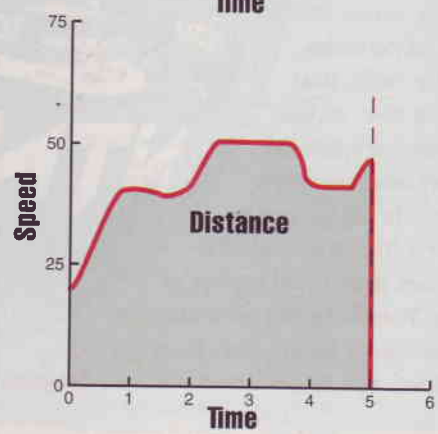
The truth, as usual, is that the engine with the most area under the curve, either the horsepower or torque curve, is the one that will be faster

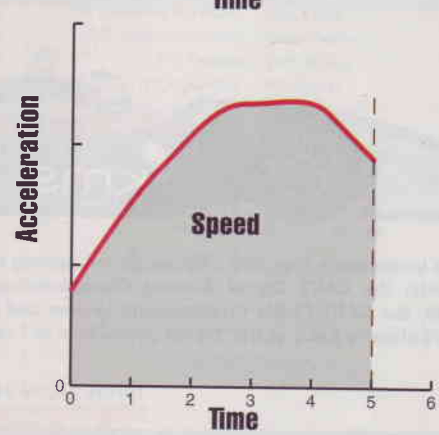
It will, if you look at an example. Say you plot speed on the y-axis and time on the x-axis for a car that is going a constant 1 mile per minute (that's 60 mph) for 5 minutes. Even without a graph, it's pretty simple to figure out how far the car traveled. Speed times time equals distance, so the car traveled five miles. Great.

But guess what? The area under that curve (which happens to be a line, in this case) is exactly the same thing. Since the area under this curve is a rectangle, area simply equals length times width, or speed times time. Amazing. This parity remains even when the curve is a strange shape, so if that same car wandered through traffic making an erratic speed vs. time curve, the area under that curve would still be the distance traveled.

OK, so what? Let's look at something a little more exciting than wandering through traffic. How about accelerating? Acceleration multiplied by time gives you speed, so on a chart of acceleration vs. time, the area under the curve will tell you the final speed. Now here's something we can brag about. All this rambling about charts and graphs starts getting relevant when you remember that acceleration is directly proportional to force, and force is simply what torque becomes when your drive wheels hit the road. So, torque vs. time, along with a



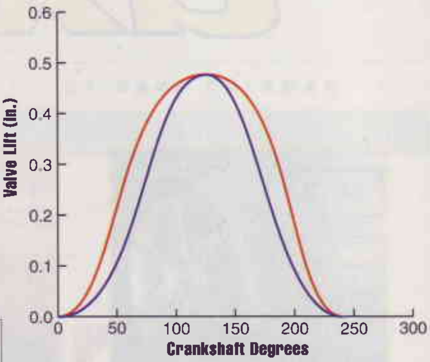




few constants like gear ratio, tire size and vehicle weight, will give you speed. Ah, ha! Now you see why the area under the torque curve is the most important of all.

This explains why the 150 hp from Volkswagen's turbocharged, five-valve 1.8T seems so much more powerful than the 150 hp from a Neon. The torque curve of the Volkswagen is tall, wide and of bountiful area.

Of course, it should be noted that torque vs. rpm, as you would get off a dyno chart, is not the same as torque vs. time. Because the car will be going faster at high rpm, the engine will spend less time around 7000 rpm than it did, say, around 3000 rpm. And, of course, to get any truly useful data, you need to look at the force at the contact patch after the engine's torque has been multiplied by the various gear ratios and divided by the radius of the wheel and tire. The area under the curve argument is still good for general comparisons, however, and is most often useful when comparing various modifications to the same car, in which case all the questions about rpm vs. time, gearing and tire size become pretty much irrelevant.



The lift profile of these two imaginary cams would have the same lift and duration specs, but the area under the curve for the red cam is much greater; it's the red cam that, most likely, would make more power.

This whole area under the curve argument isn't limited to dyno charts either. You may have noticed in our various nerdly dissertations on camshafts that the area under the lift curve comes up quite often as well. Camshafts suffer from the same oversimplified measurement conventions that engines do. Simple lift and duration values are all that most cam manufacturers offer to identify various cam grinds. Besides the lack of a standard measuring convention for these two simple numbers, the fact remains that there are countless different cam profiles that can share the same lift and duration numbers.

Optimizing the opening and closing ramps of a cam lobe can get you more area under the lift curve, more power and exactly the same numbers on the spec sheet. The cams with the best profiles often have relatively mild specs. Just as Volkswagen's 1.8T looks rather dowdy on paper.

Why don't we just calculate this all-important area for you and present a truly useful number? Of course, it's never that easy. Where does the curve start and stop on a 1.8T, and how do you compare that with the torque curve of an S2000, which has a redline almost 3000 rpm higher? As usual, lots of pretty charts are the only path to the truth. ■

Dave Anderson, President of Autobahn Designs Inc., 2000 ABD Racing Turbo Beetle