Racing Performance Services

Gearing 101

Preface

One of the most common questions in the paddock is, "What gearing should I use?" The question is generally asked with the expectation that the answer will yield a "fast setup". The examples in this document are based on a conventional “in line four” motorcycle and some adjusts should be realized for twins. It is generally one of the most useless questions a racer or track day rider can ask for the most part. The main reason for this is that VERY RARELY are motorcycles and riders similar enough to use "same settings" effectively. It is important to remember that everything between the countershaft and the pavement is a factor on your "external gearing". References in this document will only refer to external (countershaft sprocket and rear sprocket) The key factors to consider include:

1. Different tire diameter - A Michelin tire is likely to have significantly different diameter/circumference than a Pirelli or Dunlop. This means that a rider using the Michelin will have to use different sprocket sizes to get the same external gearing results as if they used the aforementioned Pirelli or Dunlop. Compounding this problem is that same brands have different sized tire diameters with the size selection within their product line (i.e. a vendor may offer a 190/50 AND A 190/60 for a rear tire choice).

2. Different bikes - Sounds simple, but many times riders of an R-6, GSXR-600, or ZX-6r believe that the motorcycles (specifically, the internal gear ratios) are the same. All motorcycles for the most part have completely different internal gearing.

3. Same bike, different year/spec - Many times a motorcycle that is the same brand, but a different year or spec will have different INTERNAL gearing. A good example of this is the ZX600. The 2000-2002 model came with 15F/40R gearing, but changed in 2004 to a 16F/48R. Obviously the internal ratios have changed on this bike although it is the same model. The 2001-2004 GSXR-600 has a similar difference from the 04 GSXR-600.

Other factors to consider are rider skill, personal rider preference, and machine performance. Although many of the faster regional club racers will use similar gearing on same models, there are just many factors that affect the individual needs of the racer at the regional/club level. So there is no "one size fits all" gearing solution for the majority of racers and track day riders.

ON WITH THE DISCUSSION…

There are some guidelines that help the individual racer select initial gearing for the track or aggressive riding. **The most successful single change is to drop one tooth off of the front**

countershaft sprocket to provide more "pull" out of the turns. Since most motorcycles come from the showroom over-geared by about 15-20 mph, this gearing solution will even accommodate the motorcycle on a long, horsepower favorable track. From this point forward, the rider must be able to fine tune the motorcycle to their individual needs. In order to achieve successful fine tuning, three factors must be taken into account. (For Reference about this section, please click here)

Gearing selection(s) that you need "on-hand"

The most successful "gear selection" is usually achieved by obtaining 3 or 4 rear sprockets that are +/- 1 or 2 teeth from stock. For instance, if you originally had a 45 tooth rear sprocket, you would also want to have a 43, 44, 46, and possibly a 47 tooth sprocket in addition to the 45 tooth sprocket. On the front you would want to have +/- 1 teeth selection for countershaft gearing changes. Dropping one tooth off the front sprocket gives you a great starting point for optimizing your gearing, while preventing you from having to replace the chain because of sprocket size.

Total tooth availability - As just mentioned, you need to keep in mind that your chain is cut for a limited amount of teeth relative to your sprockets. Most sport bikes come out of the showroom with the ability to increase your sprocket tooth count by +/- 2 teeth. The way to look at is simple.

> A motorcycle that comes with 17F/45R gearing has 62 total teeth. You can increase to 63 teeth with no expected problems. If a 64 tooth combination is a result of a rear sprocket with more than 2 teeth (i.e. 47 tooth rear sprocket), then you may move the axle up too far to actually have enough slack in the chain for safety. The reason for this is that a larger count rear sprocket ALSO has a larger diameter and consequently takes up link length. Just as a smaller diameter sprocket provides more link length by virtue of a smaller diameter sprocket.

Geometry - The last thing you want to consider is your geometry. Serious racers will keep 2 or 3 pre-cut chains to handle the different spans of gearing selections. Changing your gearing from a 17F/45R to a 16F/44R will change the wheelbase by as much as 1 inch. This means that your handling will change. Wheelbase changes over 10mm can make a noticeable difference to your motorcycles handling. Remember this when gearing. As a rule, if you do not have an extra chain, drop the rear ride height 2 mm if you have to adjust the axle/wheelbase more than 20mm forward and add 2mm of ride height if you have to adjust the axle/wheelbase more than 20mm rearwards.

How to pick your final gearing…

Picking your final gearing is important, but there are two easy ways to address gear selection. There are two distinct circumstances that dictate gearing strategy.

- Race tracks that allow speeds over 140mph on the "main" straight - This is the easiest to gear for. Initially gear your motorcycle, so that your motorcycle is about 1-3 thousand RPM from redline in 6th gear at the "fastest part" of the straight. NOW, fine tune with a rear sprocket that allows the most effective way for you to enter and exit the corners (continue on reading concerning this point).

a. SPECIAL NOTES:
   i. On Lightweight Bikes (SV650, RS125, etc), use this rule on any track where you believe that you can reach redline in sixth gear with the aforementioned gearing of -1T on the countershaft sprocket.

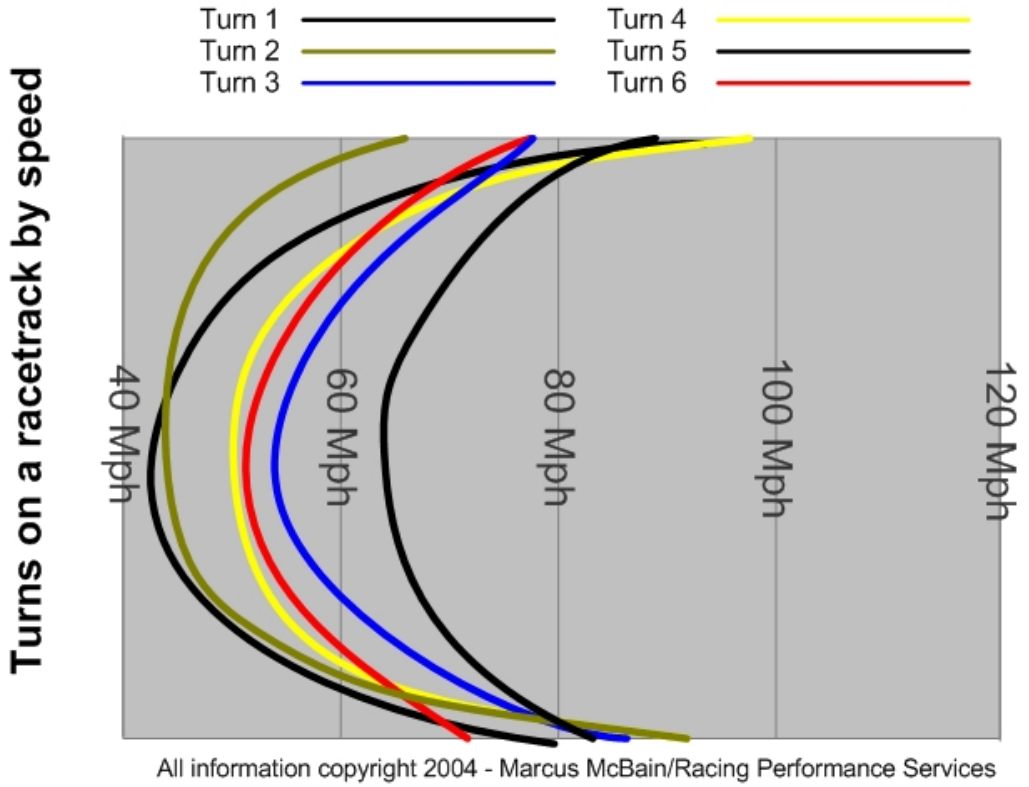
   ii. On race tracks that do not have a significant “straight” - This is where gearing is the most critical. Tracks like Hallet, Motorsport Ranch, Oak Hill, Talledega Gran Prix, Second Creek, and others do not invite usage of 6th gear on most motorcycles. You must use the strength of your gearing to maximize corner entry speed and corner exit acceleration.

   iii. On 1000cc motorcycles, you may choose to just use four or five gears or ignore the proximity to redline in sixth gear as many times drivability in the "infield" section of the course may be more important.

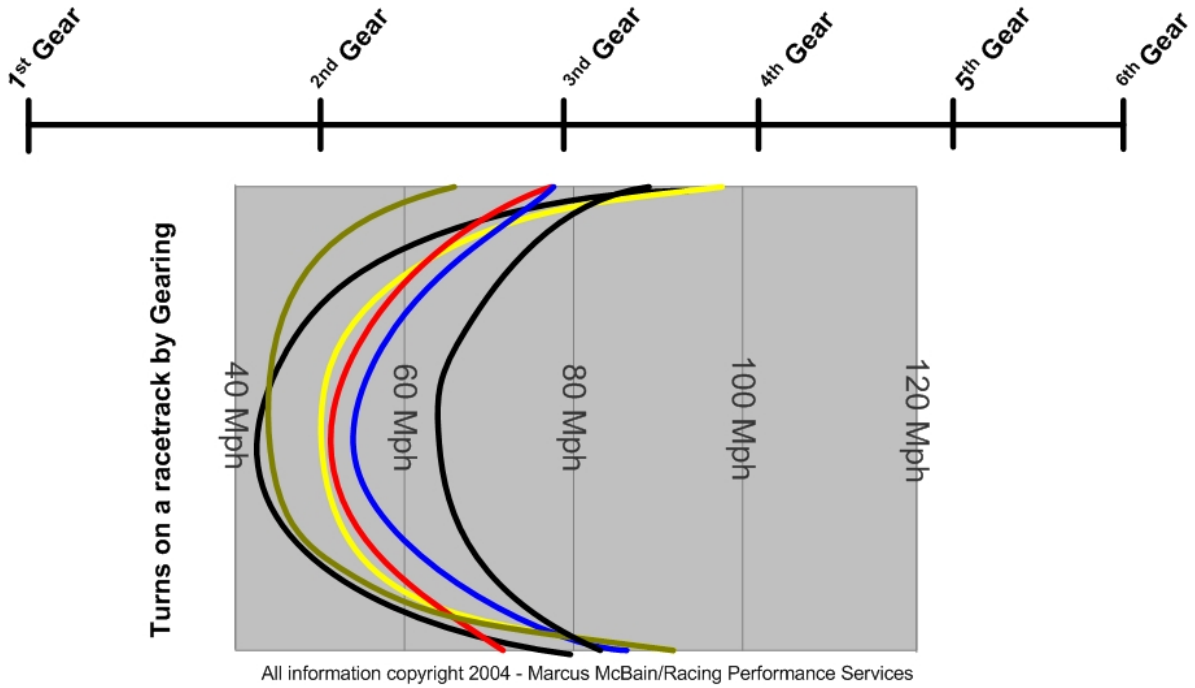
To get the bike to enter the turn without “banging off the rev limiter” OR exit without hitting the rev-limiter before you are ready to shift “up”, look at the turns after your first session and realize where AND HOW you are geared.

The following illustration(s) are provided for reference (NOTE: Speed is put in there simply as a reference for this presentation. DON'T LOOK AT YOUR SPEEDOMETER ON THE RACE TRACK).

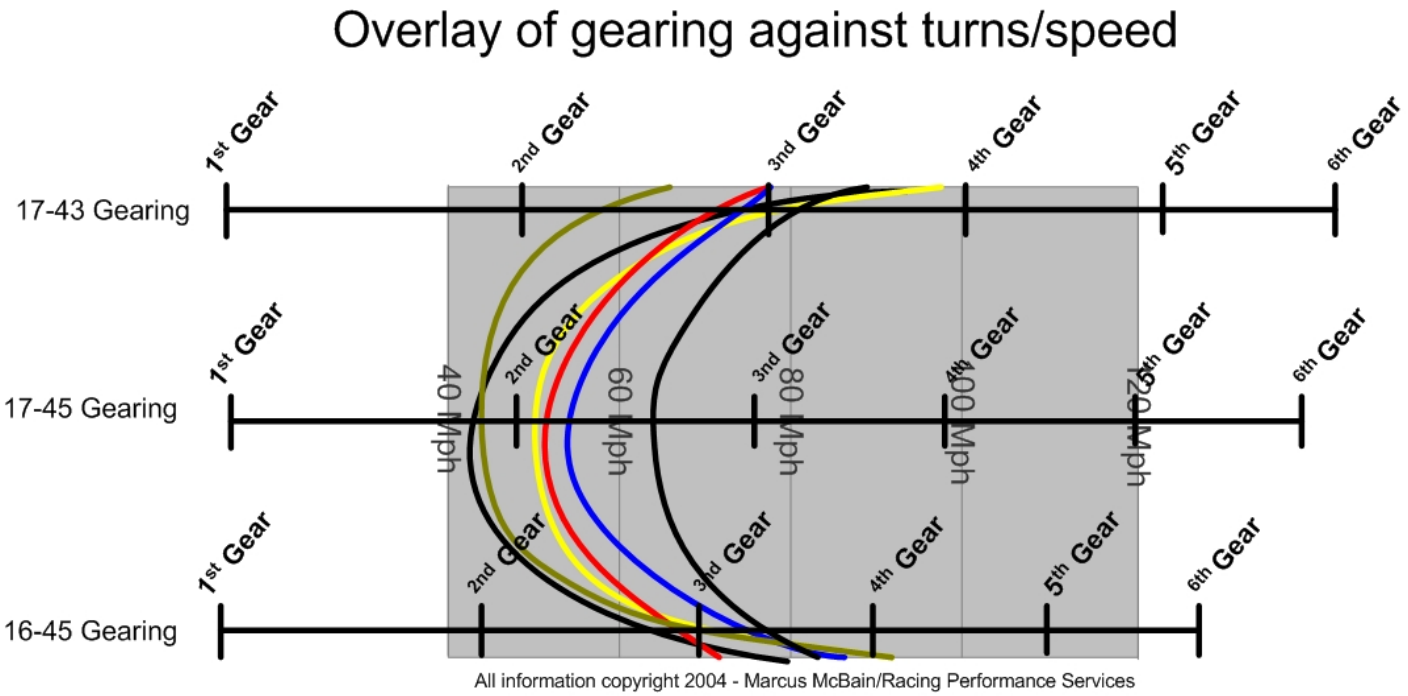
As you look at the first illustration, you may note the many different speeds that each separate turn may represent.



Next, if you could then overlay the turns and correspond the gearing to turns, it may look like this:



What we can see in the turns on a racetrack by gearing illustration is that in the current gearing configuration, a rider might be too low in the RPM's for a couple of turns and have to maybe choose 1st gear or sacrifice drive. Now if we could look at the different options on an overlay, it may look something like this:



What we see is that a 17-45 gearing solution in this example may give us the most drivability out of the turns as we do not have to shift too early in any of the turns, whereas a 16-45 gearing solution might leave us in a situation where we are shifting coming out of the turn too early and either have to choose to shift early (and upset the motorcycle) or ease up our drive to gain stability during shifting.

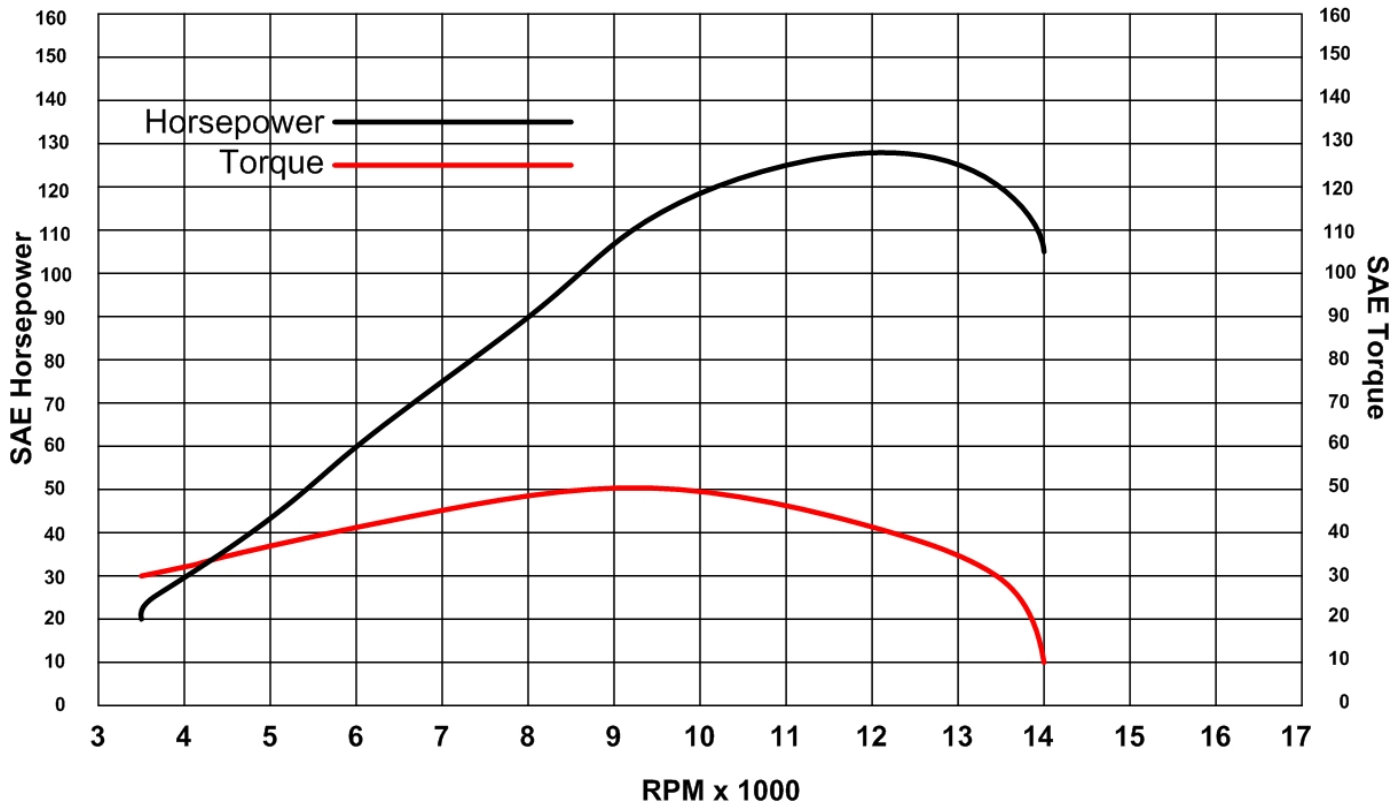
ADVANCED STRATEGY - On a big 1000cc bike or superbike gearbox that may have a 1st gear that carries up to 80mph, a rider may choose to gear something in the neighborhood of 17-42 or 17-41 gearing solution for this example and use first gear so as to ease the delivery of power. The result is that the rider may only use a few gears, but not be shifting at critical "power delivery" moments.

The way to know you got your gearing correctly selected is that as you exit the turn, you will not have shift until you are leaned over less than 10%-15% from the motorcycle being vertical situation. If you are consistently only shifting once the motorcycle is vertical, then likely you are geared "too tall". If you are shifting consistently when the motorcycle is leaned over more than 15% from vertical, you are likely geared "too short".

Advanced Technique

A smart rider will also take advantage of how the motor delivers power to optimally gear for the race track. It is important to know how and where your motorcycle makes HP and Torque. The key item to know is that overall traction performance improves on the down slope of torque.

Typical Horsepower/Torque Dyno report

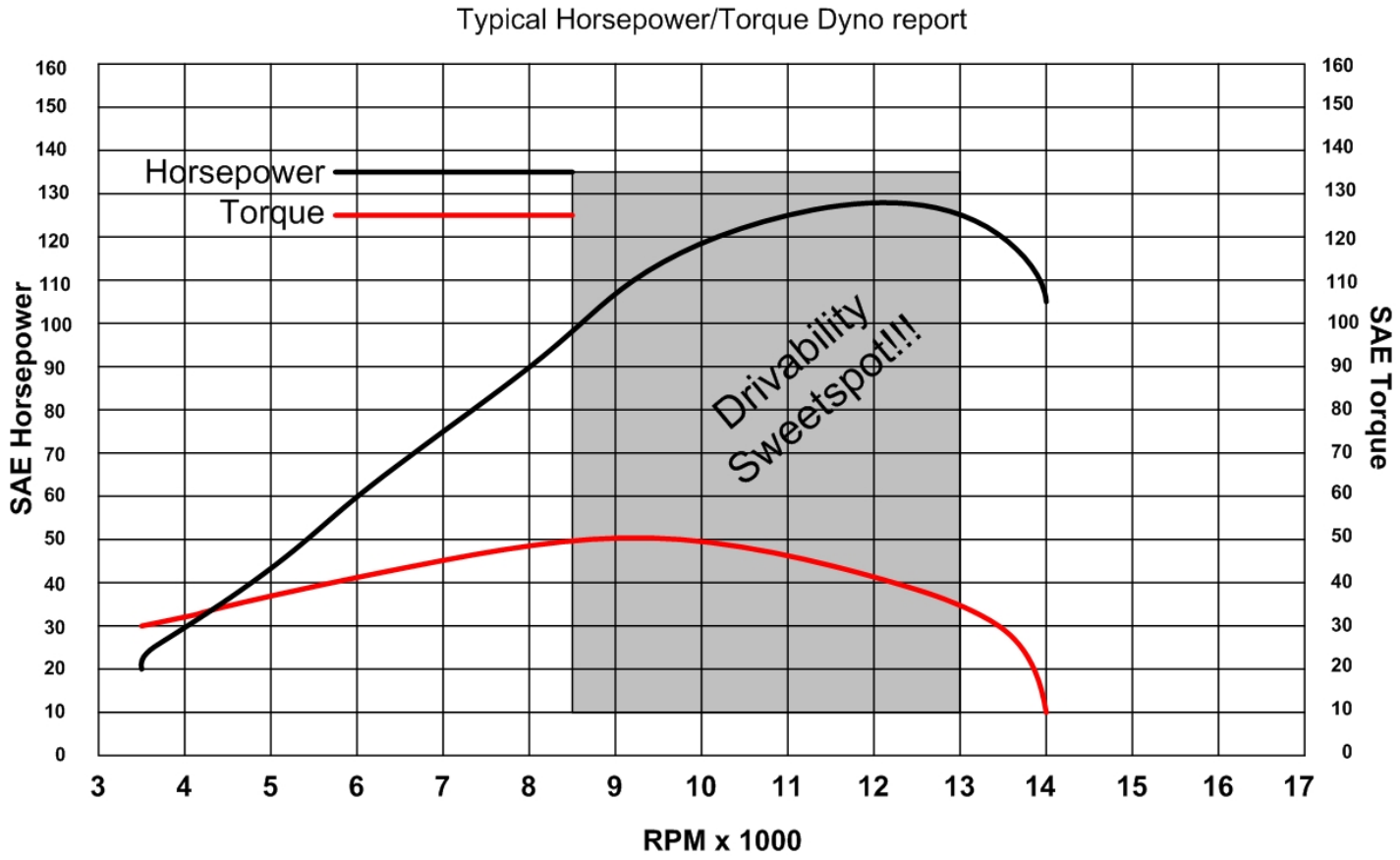


Specific to this example is the graph shown. At about 8,500 RPM, we see that the motor begins to flatten out on torque. Gearing to begin your aggressive part of your drive after 8,500 RPM will allow your motorcycle to improve overall traction on the corner exit. Ideally, you would want to race this bike and keep your RPM between 8,000 RPM and 13,000 RPM (Where HP flattens out) throughout the key acceleration points.

The HP gain in the RPM range will have a confidence inspiring effect of keeping the rear of the motorcycle squatted appropriately while the reduction in Torque will provide more consistent action in the rear suspension.

A good example of the effect of Torque and HP gains relative to traction is when you lug the motor a bit (maybe at 6,500RPM - 7,000 RPM) and the back end feels like it is “floating”. Although HP is not high, the amount of torque gained is. This provides for a feeling of the rear end "floating" as the lack of HP does not compress the suspension enough to provide optimal traction while at the same time the gain in torque does push rear traction significantly.

Many riders will experience big unexpected slides after several laps of lugging the motor like this (below the top of the torque curve) as the rear tire receives a significant workout in this situation.



We hope that this article helps you in understanding gearing and its effect on your motorcycle.

All information provided is directly from my experience in over 20 years of roadracing and several years as an instructor and trackside suspension provider.

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