The Effects of Motorcycle Gearing Changes

A discussion on motorcycle gearing, what it means, and the end result it makes to your machine

One very common modification that riders tend to make to their machines is to change the gearing.

Most commonly, riders will do this in an attempt to make their bikes accelerate quicker as stock road gearing tends to be longer than is needed for the track.

In this article I'm going to give you a relatively basic lesson on how gearing works, as well as how any changes will affect the end result you get when you twist the throttle.

What Gearing Means

From the engine all the way through to the rear wheel, gearing comes into play.

Each part of the mechanical process that gets the power from the engine to the rear wheel has it's own gearing. There are three main parts to this gearing equation.

Primary Drive – The ratio between the engine (crankshaft) and the clutch/gearbox.
The Gearbox – Each gear in the gearbox will have its own ratio, and changing what gear is selected changes the ratio that goes through to the final drive.
Final Drive – The ratio between the number of teeth on the front sprocket (the small one) and the rear wheel sprocket.
When talking about complete motorcycle gearing (all of the above) this is referred to as the total gearing ratio.

Each of the above gear ratios will determine the level of twisting force (torque) that makes it through to the rear wheel.

However, around track day and race paddocks when people refer to changing the gearing, they are almost always referring to changing the Final Drive gearing.

Quite simply, changing the size of the front and rear sprockets to alter the bike's performance characteristics.

Now, I've almost immediately started talking about 'gear ratios' with little explanation, so let me help you out...

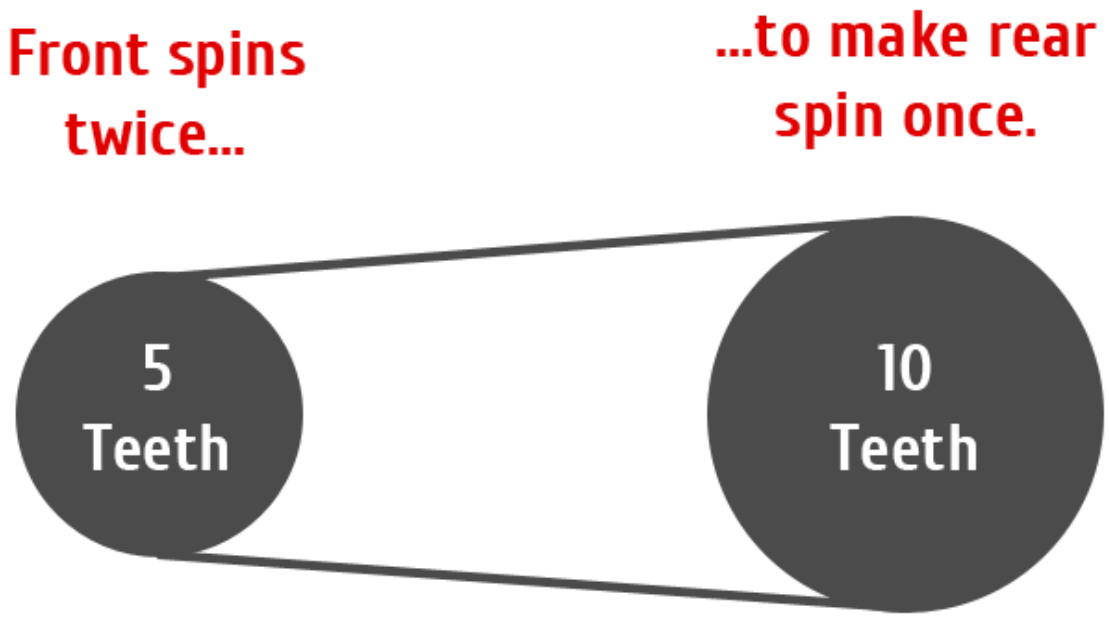
Gear Ratios

As I indicated above, each of the aspects have what's known as their own 'gear ratio'.

In real laymen's terms, this is the ratio of how many times the drive sprocket (front) has to turn before the driven sprocket (rear) turns once.

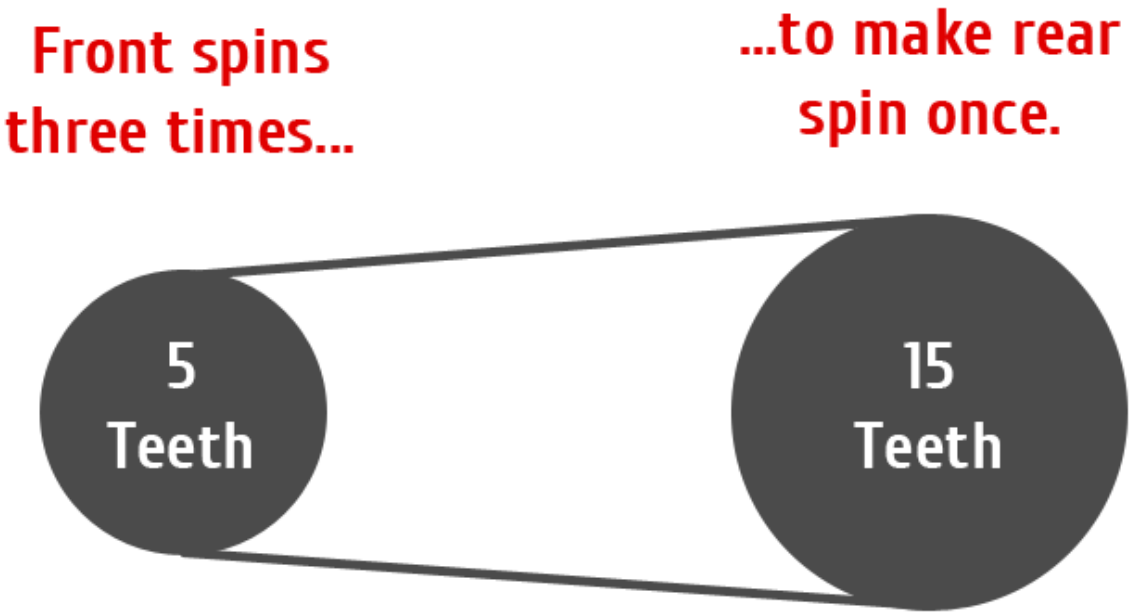
So let's assume you have a 5 tooth front sprocket and a 10 tooth rear sprocket.

In order for the rear sprocket and wheel to rotate once, the front sprocket has to rotate twice.



This ratio in written form is 2:1.

Now let's assume that you have a 5 tooth front sprocket and a 15 tooth rear sprocket. Now the front sprocket has to rotate three times in order to rotate the rear sprocket once.



The gear ratio of this arrangement would be 3:1.

To bring it to more familiar ground, here's a more typical gearing arrangement.

A 2004 Yamaha R6 in stock trim, for example, has a gear arrangement of 16 teeth on the front sprocket and 48 teeth on the back (written as 16/48).

Like the example above, in this arrangement the front sprocket needs to rotate three times in order to rotate the wheel once, giving the same gear ratio of 3:1 as the previous example.

This ratio can also be detailed as a decimal number (which will help explain the next bit), which in the instance of a 3:1 ratio is written as 0.33. This is the result of:

16 front sprocket teeth, divided by 48 rear sprocket teeth = 0.33

Now we know about the numbers and what they mean, let's clarify what that represents.

Lowering the Gearing

With stock road gearing riders often find that it is a little too 'long' for the track and they would like to 'shorten' it.

The term 'long' is used because each gear feels longer to get through than what is needed for the track, but when they talk about shortening the gearing what they actually want to do is lower it.
Lowering the gearing ratio means that you are actually increasing the difference in tooth count between the front and rear sprocket. Sounds confusing, but bear with me.
So as we know a stock 2004 Yamaha R6 has a gearing arrangement of 16/48.

A very common gearing modification to this arrangement is to go -1 tooth on the front sprocket and +2 teeth on the rear. This leaves us with 15/50.

The gear ratio is now 3.33:1, meaning the front sprocket has to rotate 3.33 times before the rear sprocket rotates once.

As a decimal number, this ratio now becomes 0.3 (15 / 50 = 0.3).

So as you can see, before the change the ratio as a decimal number was 0.33, after the change the gearing has been lowered to 0.3.

The Changes in Real Terms

We now know that lowering the gearing is what most riders want to do to improve acceleration for each given gear, so let's look at why that happens and the consequences of doing it.

In order to get the wheel to spin up quicker you can either increase the power output of the engine, or you can change the amount of torque that is applied through the rear wheel.

In real simple terms, torque is a measurement of twisting force applied to an object to rotate it about an axis.

In this instance, the torque is applied through the chain and sprocket in order to spin the wheel around the axle. More torque means the wheel will spin up easier, and therefore quicker.

By increasing the difference in tooth count between the front and rear sprocket (and lowering the gearing) you are increasing the amount of torque that is applied through the rear wheel.

The increase in torque means the wheel spins up easier and you accelerate faster.

The Trade Off

As you may already know, when you change the gearing like this the trade off comes in the way of top end speed.

By lowering the gearing you cause the rear sprocket and wheel to turn more slowly in relation to engine speed.

Slower wheel speed equates to slower road speed, meaning your bike will be going slower at any gear and RPM compared to higher gearing arrangements.

Again, to put it simply, on the red line in top gear your rear wheel will be rotating slower when using a lower gearing arrangement, meaning less top speed.

Front vs Rear Tooth Changes

You may be forgiven for thinking that a single tooth change to either the front or rear sprocket would yield the same result.

Afterall, we're just looking to increase the tooth count difference between front and rear sprocket, so why does it matter which sprocket it comes from?

It makes some sort of sense I suppose, but this isn't the case.

The ratio is determined by dividing the number of teeth on the front sprocket by the number of teeth on the back as we saw above, so a change in the number of teeth on the front sproket will have a more dramatic effect than the rear.

For example, let's go back to our original stock arrangement of 16/48 (0.33) and change a single tooth at each end separately.

Remember, we're looking to increase the gap between the two, so to lower the gearing you remove teeth from the front and add them to the back.
15 / 48 = 0.3125 gearing ratio
16 / 49 = 0.3265 gearing ratio
As you can see, removing one tooth from the front sprocket has a bigger impact than adding one tooth to the rear.
In actual fact, going down one tooth on the front is roughly the equivalent to adding three teeth to the rear. As you can see:

15 / 48 = 0.3125
vs

16 / 51 = 0.3137
Not exactly the same, but very close.

Gearing Is Always a Compromise

Consider the track you're riding and ask yourself if your gearing is correct.

Are you only ever able to get up to fourth gear on the longest straight? Or are you bouncing of the limiter in top gear half way down it?

Different bikes will favour difference arrangements at different tracks. If you're really keen like some racers or track day riders you can have multiple arrangements for different tracks.

Also consider if your current gearing is making one of more corners awkward to handle, such as leaving you too far out of the power as you exit a corner, and selecting a lower gear leaves you too high in the rev range, for example.

Like a lot of aspects of motorcycle setup, it's about finding the best compromise for the track and conditions you're riding at the time.

You likely won't find a perfect setup through sprocket changes alone, but if you're still running stock gearing then you can certainly make it a lot better.

A Couple of Caveats

Firstly, if you're making a radical gearing change from stock, there's a good chance you'll find that your existing chain length is too short (assuming you're going for a bigger sprocket at the rear to improve acceleration). It's worth finding out the recommended change length for your new configuration.

Second, if you're making a big change this will also have an effect on wheelbase, and therefore, geometry.

Be sure to check out Gearing Commander. A fantastic tool for testing theoretical gearing changes.