Horses, Gears, Why, When

Please note I am talking concepts here and figures used are purely for demonstration purposes to get the concept across; don't try to relate these figures to anything else I have said.

In the days before cars, people used to travel around by horse and carriage.

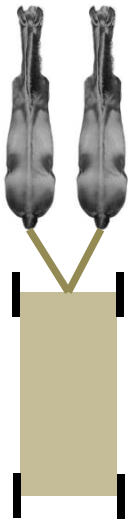
The Internal Combustion Engine was invented (just like petrol and diesel engines in today's cars) and the 'Horseless Carriage' (later shortened to car) was invented.

To sell this new mode of transport, people needed to know what they were buying.

Invented by James Watt, horsepower originally measured the amount of work that a horse lifting coal out of a coal mine could do in a minute. Back then, one HP equated to 33,000 foot-pounds. Not important but today, you can easily convert HP into different units, like 1 HP that equates to 746 Watts.

The car manufacturer could now tell people that this car has a 2hp engine and does the same amount of work as 2 horses; the engine now did the job that the horses used to.

Obviously, the more horses you have at the front of the carriage, the easier the carriage will initially move and the faster it will accelerate.



Think of my engine as being capable of outputting the same amount of power as 100 horses and the rest of the car as a carriage like you get in Cowboys and Indians movies. Here's a 2HP carriage but think of my car as a 100HP carriage.

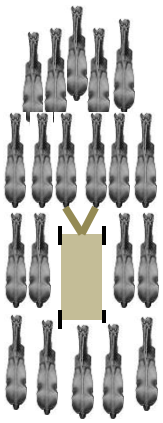
HP is a calculation based on the turning force of the engine (known as torque) multiplied by the number of Revs of an engine (also known as Revolutions or RPM – Revolutions Per Minute, because the internals of an engine go round).

HP = REVS X TORQUE

Simply, the higher the revs from the engine the more HP (or horses!) you have access to (up to a maximum limit).

Revs = Horses

We all know that an engine rises in revs as we accelerate and as we slow down, those revs drop.



Because HP is a calculation based on revs, as the revs climb we get access to more horses.

We could imagine a scene where there's a carriage in a field and the number of horses tied to that carriage are the same number that correspond to the revs of the engine (they can be tied anywhere on the carriage, not just in front). 20HP

So at 1000rpm you have 20 horses available to you; as the revs climb more horses just appear like magic next to the car (if the revs dropped then the horses would start to disappear). 2000rpm will give you 40 horses, 3000rpm gives 60, 4000rpm gives 80 and 5000 gives 100 and everything in-between i.e 1500rpm = 30hp.

Now diesel and petrol engines behave slightly differently and because my car is a diesel, I'll talk about that.

If you raise your revs above 5000rpm however, you still only have 100 horses but it's like they're running down-hill too fast and some of them are falling over. So whilst you may still have 100, the amount of useable power from them gets less as more fall over.

Revs	Horses/HP	Good?
1000	20	Good
2000	40	Good
3000	60	Good
4000	80	Good
5000	100	Good
>5000	Some of the 100 are falling over	Bad

There's no getting away from it, when driving, the revs of the engine relate to how many horses you have brought with you.

Pros and Cons

Don't forget that there are good and bad points to having horses though.

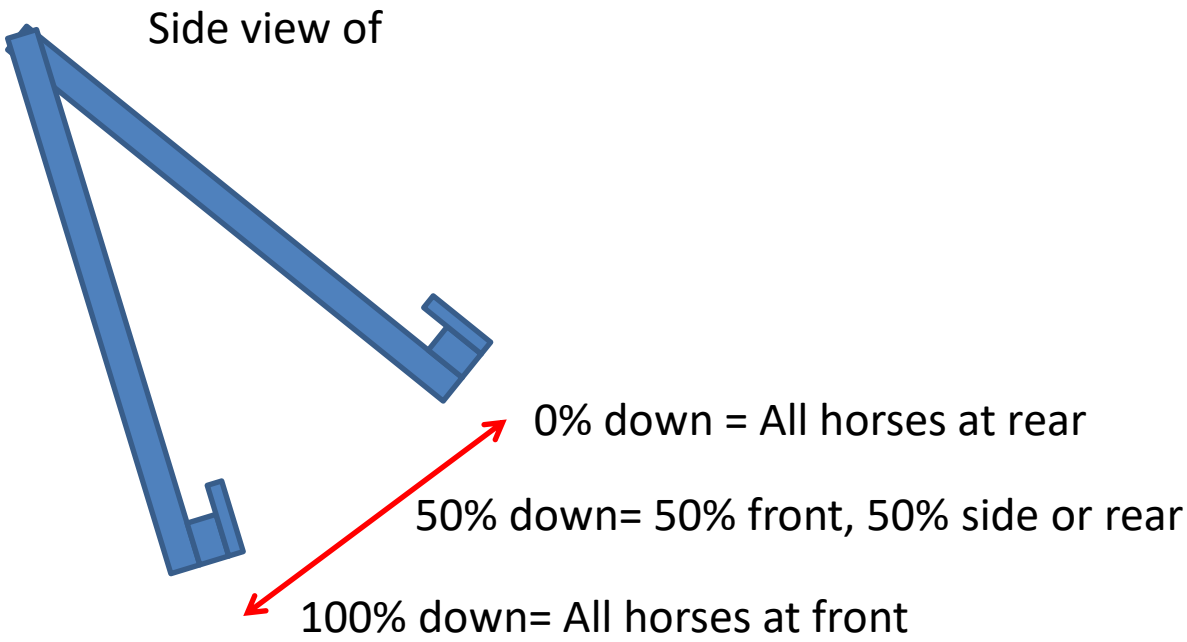
A horse equals power and that's good, but having a horse also means:

1. You need to feed it fuel (diesel for a car, hay for a horse), so it's expensive!
2. Horses fart and cars emit pollution, so more emissions.
3. Horses talk to each other and make noise and high revs are noisy, so noise pollution.

So that's 1 positive to 3 negatives! Really, we only want to bring horses when we need them, otherwise it's wasteful and bad for the environment.

The accelerator

The accelerator decides where the horses are positioned on a car like this:



So if the engine is at 1000rpm; we have access to 20 horses. If we push the accelerator down 50%, 10 horses are tied to the front and 10 are on the side or rear.

To summarise so far

Revs = horses. The more horses you have, the more power you have access to.
If you go into 5000rpm or higher, then your horses start falling over and the amount of power you have access to starts to drop.
The accelerator decides how you place the horses around the car, foot to the floor = maximum acceleration as 100% of the horses are used at the front. Take your foot off the accelerator and 100% of the horses go to the back of the car and you start to slow down.
You can move the horses around the car depending on how hard you push the accelerator.

Choose the right Gear to choose the right rev

Fact:
The higher the gear, the lower the rev
The lower the gear, the higher the rev

I know this might sounds crazy, but make the sound of a car accelerating and going up through the gears. Every time you go up a gear you drop the sound of the engine.

When you do a gear change you are at the same speed, it's just that you changed the gear, i.e:

1. Accelerate to 10mph,
2. Change from 1st to 2nd, you're still doing 10mph at this point.
3. Now accelerate again to raise to a different speed.

What's happened is that the revs have dropped so that you can build them again, but when you changed the revs you were doing 10mph.

We can therefore say that changing gears changes revs!

So how do we use this knowledge then?

The world around us is acting upon the car and forces are there trying to slow us down or accelerate us. We want to move the car but we need to take these forces into account.

There are two factors we need to account for:

1. The number of horses we are bringing and therefore potentially the number of horses we're not utilising and wasting and
2. How hard we are pressing the accelerator.

As a general guide, the lighter you press the accelerator, the less fuel is being pushed into the engine and so the more efficient the engine is.

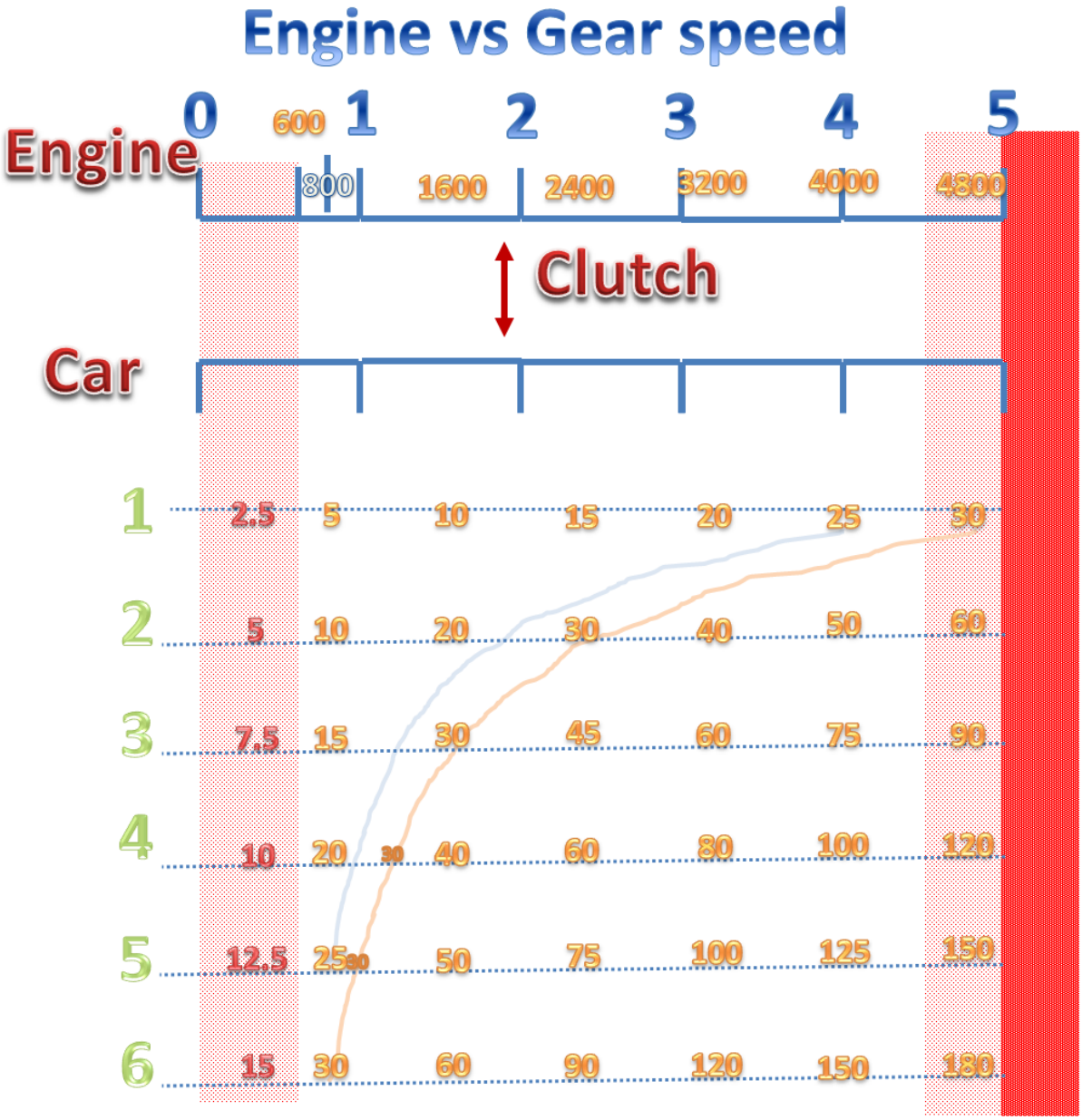
However, the lower the revs of an engine, the less work the engine does in the same period of time – which is also economical.

WHAT WE'RE LOOKING FOR IS THE IDEAL SITUATION WHEREBY WE CAN HAVE LOW REVS AND LIGHTLY PRESS THE ACCELERATOR

It might be more economical to lightly use a higher revving engine than have to push hard on a low revving engine. You will get a feel for it as you drive more.

Gear choice

The gear you pick changes the revs of the engine, the rev you have changes the number of horses. This is my actual car gearing and how it behaves.



Assuming a 100hp engine at 5000rpm, the diagram shows that **at 30mph** my car would be doing this:

Gear	Rev	Horses
1	4800	96
2	2400	48
3	1600	32
4	1200	24
5	960	19.2
6	800	16

Scenario 1

We are driving along a flat road with very little wind against the car doing 30mph. Taking into account all forces acting against the car, we have a combined resistance of 10HP.

10HP slowing

So, just to maintain our current speed we have to produce 10 horses tied to the front of the car. If we supply less than 10 we will slow down, if we produce more than 10, we will accelerate.

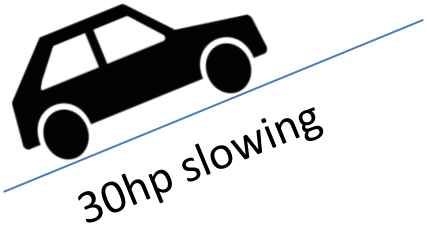
These are the options:

Gear	Rev	Horses	Accelerator %	Used horses	Good?	Comment
6	800	16	62.5	10	Good ish	Only 6 horses unused, quite hard on the accelerator though. It'll work though.
5	960	19.2	52	10	Good	9.2 horses wasted but accelerator only half way down, not much wastage and light on the pedal – I like it!
4	1200	24	41.7	10	Good	12 horses wasted but only 42% down – probably the most efficient
3	1600	32	31.25	10	Good ish	22 horses wasted but 31% down, a bit wasteful…
2	2400	48	20.8	10	Bad	38 horses too many, starting to sound loud
1	4800	96	10.4	10	Bad	86 horses too many, you sound like a boy racer and are polluting the world – stop it!!

As you can see, often there isn't one good gear, there are multiples and you need to pick the one you feel is best at the time.

Scenario 2

We are driving up a hill; there is a combined resistance of 30HP



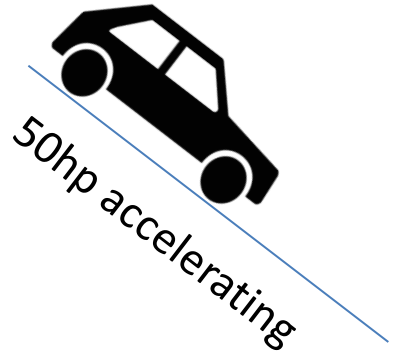
We need 30HP to maintain our current speed, anything less than 30 horses tied to the front and we will slow down, tie more to the front and we will accelerate.

These are the options:

Gear	Rev	Horses	Accelerator %	Used horses	Good?	Comment
6	800	16	100	16	Bad	We need 30 horses and can only supply 16. The car will get slower and stall.
5	960	19.2	100	19.2	Bad	We need 30 horses and can only supply 19.2. The car will get slower and stall.
4	1200	24	100	24	Bad	We need 30 horses and can only supply 24. The car will get slower and stall.
3	1600	32	93.75	30	Good ish	2 horses wasted but 94% down, very little scope for improving performance if you want it…
2	2400	48	62.5	30	Good	18 horses wasted, 62% down, you will have some acceleration if you want it, starting to sound loud
1	4800	96	31.25	30	Good ish / Bad	66 horses too many, good scope for acceleration if you plan on doing so soon but very wasteful if you're not planning on accelerating. You sound like a boy racer and are polluting the world.

Scenario 3

We are driving down a steep hill and the hill is trying to accelerate us with the force of 50 horses.



We need 50HP to maintain our current speed but his time tied to the back of the car, anything less than 50 horses tied to the back and we will accelerate down hill; tie more to the back and we will slow down. Remember, that the more you win by the more you will act in that direction. I.e. winning by 25 in any direction will have a greater affect than winning by 5.

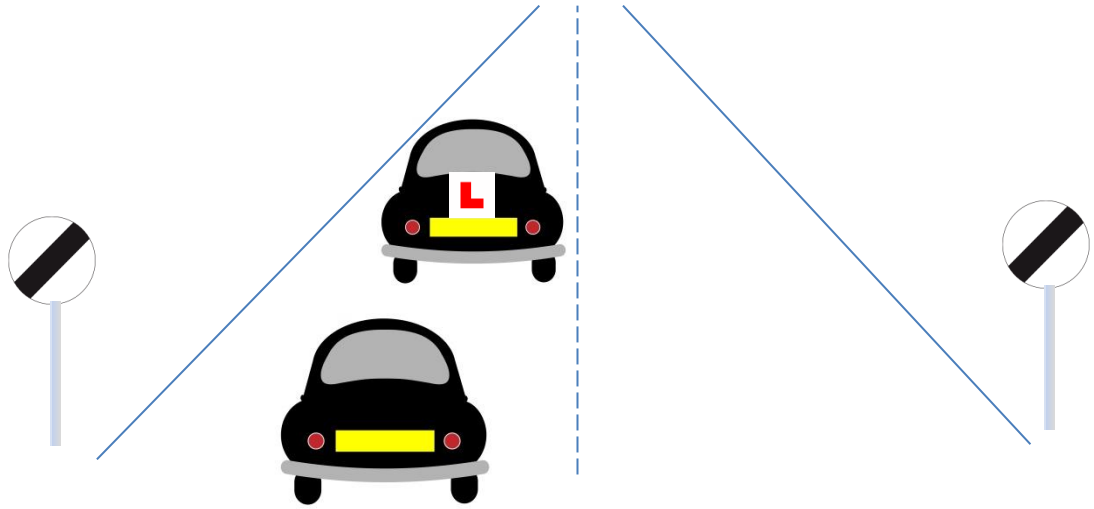
These are the options:

Gear	Rev	Horses	Accelerator %	Used horses	Good?	Comment
6	800	16	0	16	Bad	We need 50 horses and can only supply 16. The car will speed up.
5	960	19.2	0	19.2	Bad	We need 50 horses and can only supply 19.2. The car will speed up.
4	1200	24	0	24	Bad	We need 50 horses and can only supply 24. The car will speed up.
3	1600	32	0	32	Bad	We need 50 horses and can only supply 32. The car will speed up.
2	2400	48	0	48	Bad	We need 50 horses and can only supply 48. The car will speed up.
1	4800	96	48	50	Good	The only gear we can use. Push the accelerator down half way to reduce the impact of engine braking and you can control the speed of the car.

Let's not forget that if you are on a small hill, using the brake pedal is more efficient than going into 1st gear and solely using engine braking. I am trying to demonstrate how changing gears can enhance car control in these examples.

Scenario 4

We are stuck behind one of those bloody learner drivers who doesn't use their eyes. They've gone from a 30 into a national speed limit (60 on this road). We need to overtake them.



The road has a resistance of 10 horses so all the time we were in the 30 zone I would behave as per scenario 1.

As we approach the national speed limit, I would prepare the car and drive at 30 but with extra horses. We do this because as soon as we get into the 60 zone, we need to blast passed the learner and get up to 60 before we get stuck behind them if other traffic arrives.

These are the options:

Gear	Rev	Horses	Accelerator %	Used horses	Good?	Comment
6	800	16	62.5	10	Bad	Only 6 horses unused, good for economy but we need power! We need horses!
5	960	19.2	52	10	Bad	Only 9.2 horses in reserve when we hit the accelerator; we can do better.
4	1200	24	41.7	10	Bad	Only 12 horses in reserve when we hit the accelerator; we can do better.
3	1600	32	31.25	10	Good ish	22 horses in reserve, getting better, we'd have a luke-warm level of acceleration.
2	2400	48	20.8	10	Good	38 horses in reserve – good! We'll have loads of power and the revs can climb a long way before we need to change gear.
1	4800	96	10.4	10	Bad	86 horses is an excellent amount of horses to aid with acceleration, but we have to gear change when we

						increase revs by just 200rpm, so you'd have to change into 2nd as soon as you hit the accelerator. You may as well just start in 2nd.

Now we have the correct gear selected, as soon as the opportunity arises, put the accelerator on the floor and go for it; don't muck about, really go for it. The longer you take to overtake something, the longer you are in the path of potential oncoming traffic and therefore there's a real chance of a head on collision – not nice!

According to the earlier diagram, 2nd gear can get you to 60mph. I would therefore accelerate from 30 to 60 in 2nd gear and then do a block change from 2nd into 6th. I do this because my priorities have changed from 'accelerate' to 'cruise'.