

So there it is - 'Sitting in the Driveway'!

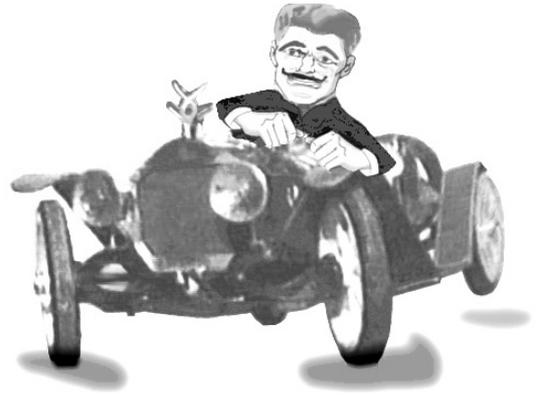
After many months, you have finally finished building your dream car, but for some reason it just doesn't drive like the car you always wanted.

Are you 'Spaced Out' too much?

Using spacers to offset wheels can make your steering hyper-sensitive and cause the car to 'wander' and feel unpredictable.

Once the offset reaches a point, where there becomes significant leverage about the swivel axis, the steering will react with increasing nervousness. Every dip and bump in the road will start to become a feared entity, cambered roads will start to test your muscular prowess, as you wrestle the wheel to maintain directional control.

Does this sound like your car?

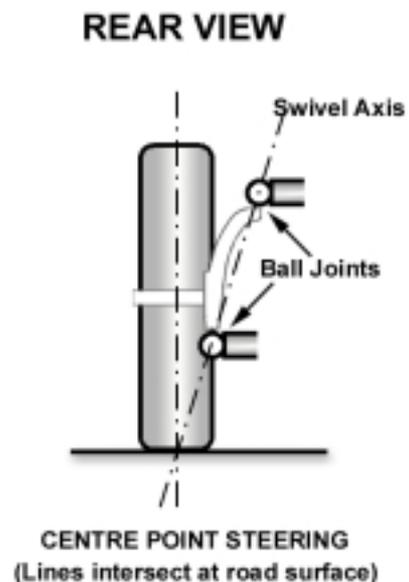
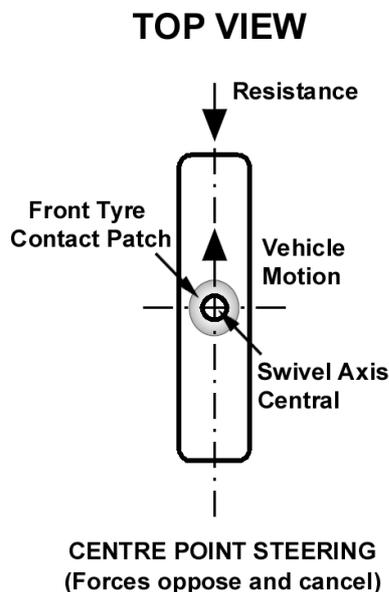


Well the big issue here is - What can be done to improve the situation?

There is an old adage - 'Knowledge is the key', well it certainly is in this case. I know 'theory' is a dirty word to a lot of people, but it is important to understand what is causing your problems, if you want to try and do something about curing them! Unless of course you have got big bucks to spend and then you just take it somewhere to get fixed. Most people who have just shelled out hard earned 'wad' to build their own kit, trim it and then deck it out with all mod cons, probably don't relish the thought of digging much deeper into the pocket to try and have some mystery complaint fixed. You know the one where the guy says - 'we think we cured it this time, it should be a lot better now, if not bring it back and we'll have another look at it!' as he passes you a big fat invoice. - Heard it before have you?

What is 'Centre Point Steering'?

To try and make cars stable, responsive and yet light on the steering, designers would like to make sure that a line extended from the steering ball joint swivel axis, intersects, with a centreline drawn around the tyre, as they both meet the road surface.

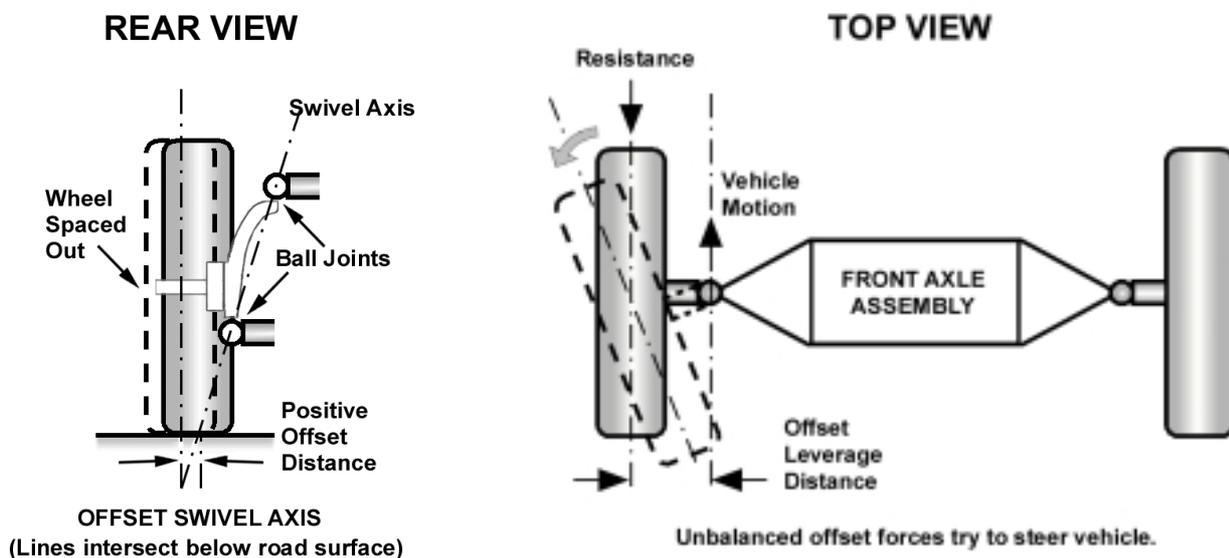


The principal idea behind centre point steering is that if either steered wheel should hit a bump in the road, it should have no effect on the intended direction of travel. Because the forward force of the vehicle, which is transferred through the swivel axis, meets any resistance to forward motion of the wheel, head on. Therefore there are no misaligned or sideways forces to deflect the steered wheel.

Although this is called Centre Point Steering, in actual fact the centre of the tyre's contact pressure patch on the road, usually falls slightly behind the swivel axis point and the amount it falls behind is called 'trail'. (Ed. We will deal with the importance of trail next month.)

What is 'Offset Swivel Axis Steering'?

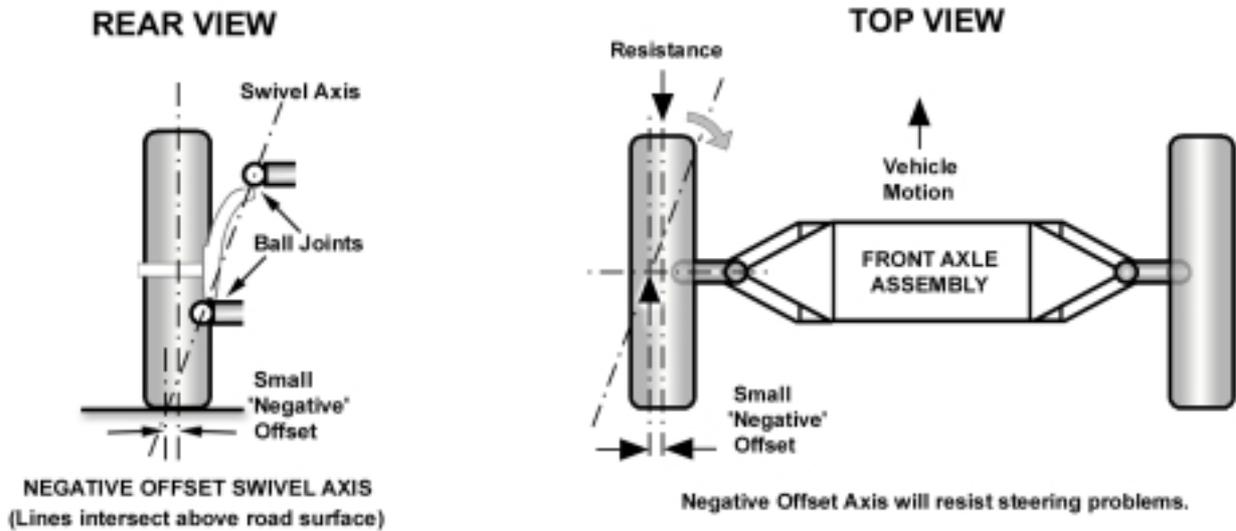
When the swivel axis line does not meet with the wheels centre line at the road surface, it is said to be 'offset'. Although a small amount of offset can be desirable, too much offset, or offset the wrong way, can cause driving our dream machine to be a nightmare.



As can be seen from the positive offset swivel axis steering diagrams, the misaligned forces about the swivel axis, will cause a leveraging effect on the front steered wheels of a vehicle. Under 'normal' conditions on a flat level road and in a straight line, the twisting effect on one front wheel, will be cancelled out by equal forces, acting on the opposite wheel. So as far as the driver is concerned under these conditions the car will feel OK. Unfortunately, in the 'real world' these forces do not stay as balanced as we would like them to. If one front wheel meets some extra resistance, the forces become unbalanced. I.e. Upon hitting a bump, the wheel is jolted back and with the positive offset situation shown, dragged outwards, therefore the car will tend to steer off course, and towards the side of the increased resistance.

Give me 'Negative Offset'!

Despite the apparent advantages of Centre Point Steering, for many reasons it is not often used. Although this is sometimes due to space limitations within certain shaped wheel dishes, especially on small wheels, which can prevent the possibility of achieving Centre Point Steering. It is more likely to be, because it is more desirable to actually have a small amount of 'negative offset' built in to the system.

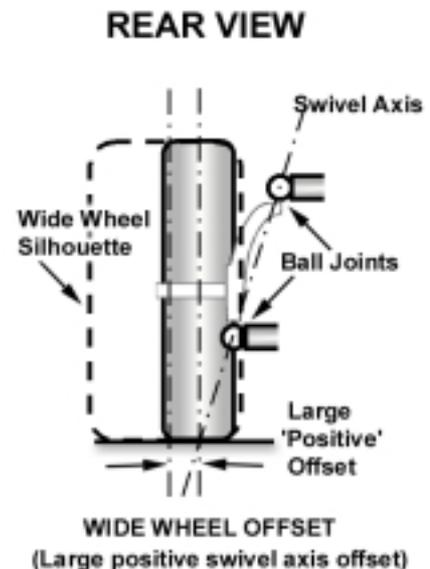


Now while this might initially look as bad as having positive offset at first glance, let us consider what actually happens when we encounter adverse operating conditions, i.e. puncture, road bumps, partial brake failure, etc. Whereas with positive offset, hitting a bump tried to turn the vehicle outward about the obstacle and caused the car to veer off course, negative offset actually opposes this. The extra drag induced, tries to turn the road wheel inward and helps prevent deflection from a straight line. This reduces any 'tug' at the steering wheel and provides a much more stable ride. In the case of a puncture or 'one sided' braking, again the offending wheel helps keep the vehicle in a straight line by steering slightly inwards, therefore reducing instead of exaggerating any problem. It is because of these advantages that most manufacturers of modern cars now try and build in a small amount of negative offset.

Spacers and Wide Wheels.

The use of spacers or wide wheels, will tend to make any offset positive. When used together, the resulting combination can be quite dramatic, in the worst possible sense. The heavy steering feel at low speed, when a car is fitted with very wide wheels and spacers, is not just due to road friction and the extra tyre surface area. The offset produced by this set-up, means that as you turn the wheel, you are effectively 'dragging' the whole car around the swivel axis!

If you are going to fit very wide tyres, try and see if you can obtain wheel rims that will extend inwards towards the car, as well as outwards. This will help counterbalance any undesirable forces through the steering. But remember - do check the available wheel clearance or you will have a very limited steering lock!!!



To Summarise the situation -

Problem: Heavy steering, or serious directional instability.

When: If a bump is encountered by only one of the front wheels. Driving along a steeply cambered road. Braking with out of balance front brakes. Braking with uneven front tyre traction (road grip).

Cause: Front axle assemblies, due to - Misalignment, Incorrectly assembly, Serious wear, Uneducated modification or Poor design.

Solution: Understand likely cause of problem, plus diligent checking for faults.

What can we check then?

To start we will assume that the manufacturers have got it correct (not always the case mind you, but probably most likely!). So what might you have done to cause a problem? Errrr - Ok, so it could be inadvertent!

List 1 - What could I have done wrong?

'Hit a Kerb, fitted bent or non-standard parts, altered the suspension height, poor servicing.'

- i) *Hitting a kerb can bend wishbones, track control arms or hubs assemblies.*
Even slight misalignments in these components, can cause dramatic steering problems.
- ii) *Fitted bent parts. I.e. Track control arm, wishbone or hub assembly.*
How do you know that any second hand parts you have fitted were not involved in an accident?
- iii) *Raised or lowered the suspension, creating 'funny' track control arm angles.*
It would be a very rare situation indeed, to be able to 'simply' alter a car's suspension height, without affecting steering adversely. Even when standard suspension travels up and down, the swivel axis offset moves all over the place.
- iv) *Fitted non-standard length track control arms, or tilting/adjusting, your top struts too far to provide extra camber.*
Varying track control arm length, will adjust the vertical angle of the road wheel to the ground (known as camber), which is a critical factor in determining steering offset. Tilting struts will have the same effect. On some cars, it is possible to accidentally fit the top suspension trunion reversed, which also alters the front wheel camber.

List 2 - What else could I have done wrong?

- i) *Fitting different diameter, spaced out, or wide front wheels.*
As can be seen from the diagrams above, excessive wheel spacing, or fitting extra wide front wheels can cause serious offset problems. What is not generally realised is that to the angle of the swivel axis, fitting taller or smaller wheels will also cause offset alterations. Taller wheels increase negative offset and small diameter wheels, or lower profile tyres will increase positive offset.
- ii) *Worn or broken suspension spring, uneven tyre pressures, odd sized front tyre.*
If a car leans to one side, the front steering geometry changes dramatically. This is why road springs are normally sold in pairs, a weak or broken spring will cause problems, (Range Rovers are an exception here, they have a different springs fitted all round!). Low pressure in a front tyre will cause the suspension to sag in that corner, increasing not only tyre drag, but also the positive offset, this is why cars with a flat front tyre, tend to pull towards the side with the puncture. Accidentally fitting an odd sized tyre is not unknown, believe me the effect of this on handling can be horrendous, as the vehicle will pitch into each corner.

iii) *Uneven tyre wear.*

On an unevenly worn tyre the centre of pressure will vary, causing the offset to stray from standard, and sometimes even change as the wheel rotates.

iv) *Odd make front tyre.*

This will affect steering during acceleration (FWD), or braking. Differing tyre traction could be caused through many things in this instance, such as - odd tyres (on the front 'heaven forbid'), a steeply cambered road providing more weight/grip on the inside wheels, uneven tyre pressures, road surface condition varying, a worn tyre or wheel alignment problems.

Yes it's a big list and I have probably missed some, but you really ought to start looking here before you go screaming at the (poor old) manufacturer - who probably sweated blood making sure it should have all been correct, however you decided to build it!

Check the easy and obvious items first and note well - Bent components are virtually impossible to see by eye! Most motorists will not have the specialised equipment at hand, to do a full axis alignment steering check, which would be necessary to find small deformities in accident damaged parts and unfortunately not all garages understand how to use their equipment properly, or interpret the readings afterwards (You doubt me? I used to train mechanics!).

But bearing this in mind, there are enough factors listed here that are within our control to check properly. Use common sense to determine the likelihood of damaged or modified parts, before you go mad rushing out and purchasing all new expensive bits!

A careful balancing act!

Take heart, it is possible to combine some adjustments to cancel out negative steering effects! For instance, if you want to fit wide or spaced wheels, and are also prepared to fit larger diameter. Then with careful planning, these two modifications will work together beautifully, to provide near standard steering properties.

Quite often, a lot of steering related problems can be improved tremendously, just by fitting a 'matched' pair of new front tyres!

What next?

Still got steering problems and the answer was not in the list above? DON'T scream at the manufacturer yet! Steering is a massive and complicated topic, F1 teams agonise over the smallest of adjustments and a slight miscalculation here will cost them the race. Is there any hope? Yes, the next article in this series will deal with the effects off 'Toe', 'Trail' and 'Camber', what they are, why its important and how their adjustment will affect our motorised dream machine!

Article - Adrian Harris