

Vehicle Dynamics

How vehicles behave on road is rarely described. This article explains what happens, in non-academic terms. It was originally published, but with different layout and minor text changes in the Australian publication *Caravan World* in mid 2010.



Recreational (as opposed to Romany) caravans date back at least to Dr Gordon Stables' horse-drawn 'Wanderer' of the late 1800s. Vehicle drawn caravans were common by the mid-1920s, but from the very beginning, encountered handling problems. Little has changed since. Apart from studies at Bath University (UK), a few academics, and the military in the UK and USA, the trailer industry awaits a latter-day Maurice Olley to fully explain why. The following attempts to précis current thinking (and some views of my own resulting from close to fifty years interest).

became available: initially of oversized-bicycle proportions and behaving much like softer but still solid tyres. When they ran out of the little grip they had, they slid in a relatively gentle manner.

(I have experienced this frequently -

In 1686, Sir Isaac Newton deduced that, unless influenced otherwise by an external force, things continue in a state of rest, or continue to move in a totally straight line.

Early farm wagons and carriages demonstrated this accidentally from time to time. They had large diameter wheels shod with iron or (and later) solid rubber tyres with front axles pivoted so they could turn in the direction they were pulled. But, as many a Western shows, the wagons would plough straight on, just as Newton predicted, if the horses lost their footing.

Tyres back then had primarily to revolve, not sink in soft going, and not fail under load. Surface grip helped restrain sliding sideways and, by levering against a tyre, (rudimentary) braking. The forces required

for traction, steering and control downhill were exerted externally, via animal and human power. Carriage suspension however was surprisingly advanced (right). The best examples totally shame many a trailer maker of today.

The advent of motive power profoundly changed all this. Horseless carriages too, were subject to Newton's findings, but the forces required for propulsion, braking and steering, now had to be applied and reacted solely through the tyres.

The issues were initially simple. Engines developed little power, so traction was rarely an issue. Nor was speed, so little braking was needed - or provided. Their solid rubber tyres rolled much where pointed, so steering too was not a problem.

Pneumatic tyres, already used for bicycles,



Early carriage suspension - surprisingly advanced. Pix: Collyn Rivers.

having owned many veteran and vintage cars in my earlier days).

By 1930 or so, cars had become far more powerful, heavier and faster, yet retained carriage-era underpinnings that had ceased to cope a decade before (it became said of the then Rolls-Royce, 'that it was a triumph of workmanship over design').

Essentially, suspension that was adequate for horse-drawn speeds had (with rare exceptions - e.g. Lancia) remained almost static, excepting for wheels that became progressively smaller in diameter, but with balloon-like tyres.

Most cars of the era handled in variously undesirable and often only semi-predictable ways.

Problems included directional instability, 'tramping' of the entire front suspension despite well balanced tyres, and a ride that was still harsh.

What was *not* realised was that the increasingly larger cross-section tyres virtually *dictated* on-road behaviour.

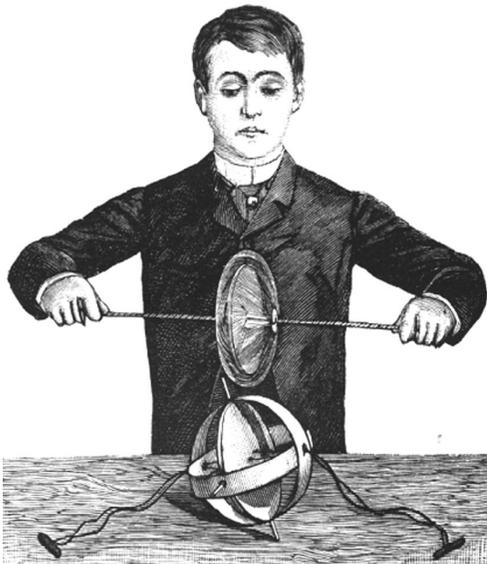
This necessitated a total rethink of vehicle dynamics. And that was superbly provided by General Motors Research Division (Special Projects) engineer, Maurice Olley.

Between 1930 and 1936, Olley studied every conceivable aspect of vehicle behaviour both theoretically and practically.

He established the basic principles that are followed to this day.

The New Era

Maurice Olley first established that the 'tramping' effect (both front wheels smashing up and down, meanwhile swinging violently from lock to lock) was due to gyroscopic precessions. This effect occurs when a fast-rotating, steerable wheel rose and fell in an arc, i.e. over bumps, and



Gyroscopic precession. Pix: courtesy Early Victorian twits.



Morgan three-wheeler 1931 - note sliding pillar independent front suspension (the author used to own one just like this. Source: unknown.

particularly with poorly damped and/or soft suspension.

This was a potentially dangerous phenomenon in that slowing down conserved the energy by decreasing the frequency but increasing the amplitude of movement - to the extent of occasional breakages.

Olley realised this disturbing and dangerous effect, imposed by gyroscopic forces, could only be prevented by eliminating those forces.

In particular, he realised that suspension geometry must allow steerable wheels to rise and fall vertically (i.e. never in the arc forced upon them by a tilting beam axle). This necessitated steered wheels to be *independently suspended*.

But Maurice Olley did not *invent* independent front suspension (IFS): Dr Lanchester did that around 1901.

HFS Morgan used IFS on his original tricar (and the much same system is still used by Morgan today!).

Dubonnet (in the late 1920s) subsequently built on that foundation, but more to reduce unsprung mass and improve the ride, than as a fundamental necessity.

Olley was almost certainly the first to understand the full implications.

His work, mainly from 1931-1938, completely changed the motor industry's understanding of vehicle dynamics, particularly how the tyres of that era (and still today) actually behaved, and why and how that behaviour still virtually *dictates* a road vehicle's design, and on-road behaviour.

Tyre Behaviour

A correctly inflated tyre does not so much roll over the surface as lay down a rectangular section of tread (footprint) of which the *length* of that footprint is

substantially proportional to tyre pressure.

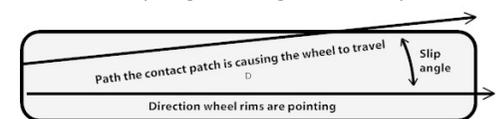
Its action is more akin to a caterpillar track than a rotating wheel and, that aptly called 'footprint', grips the surface with considerable tenacity.

Steering action is akin to twisting an inflated balloon. The steering mechanism applies torque, via the wheels' rims, to the tyres' sidewalls. These flex, and (primarily) via the air compressed within, cause the footprint to distort in the direction required. But, because the footprint is deflected via a springy media, it never totally takes up the angle that the steered road wheels attempt to impose.

Unsteered tyres act similarly. As a vehicle turns, it still attempts to continue in a straight line, and forces the so generated thrust slip angles upon them. Side winds and/or road cambers too, cause sidewalls to be deflected laterally.

Slip Angles

The angular difference between where wheels *point* and their footprints *lead*, is called the 'slip angle'. The greater the tyre



The so-called 'slip angle' formed whilst cornering - the tyres does not so much slip as distort.

width and tread stability, the stiffer the sidewalls, and the higher the tyre pressure, the less the slip angle. Conversely, it increases with the applied forces, and loads.

Under normal conditions, the footprint does not actually slip as such, instead, it is subjected, by torque applied by the sidewalls, to a diagonal-like stretching/distortion. (It's a bit like pulling a weight via a rubber band.)

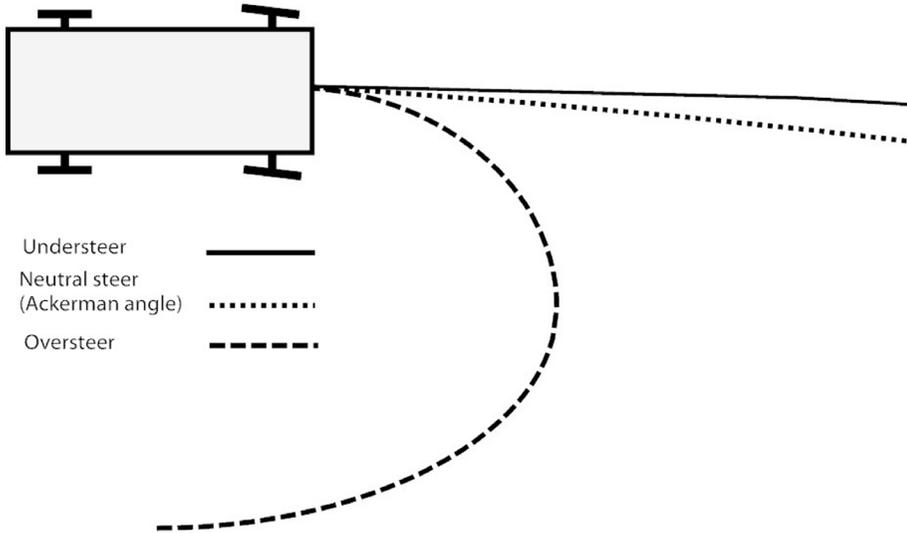
Having established the above, Maurice

Olley showed how the way in which slip angles interact substantially dictates how a road vehicle behaves.

He showed that, if front/rear slip angles remain identical, a vehicle maintains a

load front/rear - but less of an issue until-overhung rear luggage boots replaced Jeeves carrying the Bentley owners luggage in the following Rolls-Royce.

If the rear slip angle *exceeds* that of the



Pneumatically tyred vehicles of today follow the upper (mild understeering) path. Middle curve is that of a solid tyre. Lower: that of an early VW if cornered too hard!

balanced state. If driven in a circle with the steering wheel held constant, it will continue to follow a curve that increases in radius as speed increases.

This condition, known as neutral steer, causes a car to feel 'responsive', but results also in wind gusts and changes in road camber necessitating constant albeit minor steering correction.

A neutrally steering car thus tends to be demanding and tiring to drive, and less than safe for semi- and unskilled drivers.

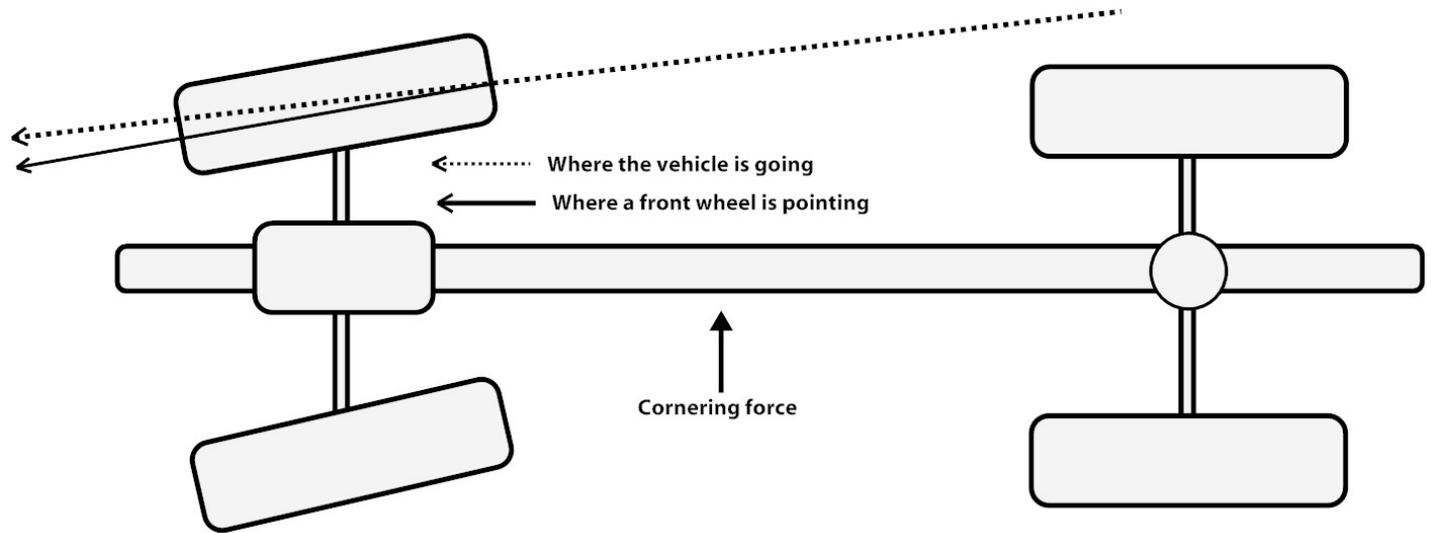
Further, maintaining that neutral balance precluded any substantial changing in

front (e.g. early Porsches), if circled as above, the car feels even more responsive. It turns in a tightening spiral, with slip angles progressively increasing as it turns.

If not corrected (by applying opposite steering lock, or reducing speed) slip angles may increase until the rear tyres' footprints lose control, and the vehicle spins. This (unstable) condition is called 'oversteer'.

For most drivers and conditions, optimum balance requires front slip angles to exceed rear slip angles by a slight but totally maintained degree.

The effect, called understeer, causes



Tyre slip angles: cornering forces act such that the tyres footprint follows an arc that is wider than that traced by the wheels' rims. If cornering a little too fast, the slightly greater slip angle at the front causes the vehicle to run wide slightly, thus increasing the radius of turn and decreasing the turning forces.



Pix 7. The MC2 suspension of the author's own TVan. Big coil springs and (Koni) shock absorbers (the disk brakes here are not standard). Pix: courtesy of Caravan & Motorhome Books, Broome, WA.

vehicles to veer slightly away from side-disturbing forces (as does a correctly trimmed yacht and all modern aircraft).

Thus, if cornered too fast, and understeering vehicle *automatically* runs slightly wide thus reducing the slip angles and hence forces.

Understeering vehicles (now virtually *all* post late-1950s vehicles) are marginally less responsive to steering input, but safer for most drivers.

People in disciplines as dissimilar as economics and PA systems will recognise this automatically-correcting action as *negative feedback*.

Maintaining the Footprint

Major problems may arise when suppliers and trailer builders modify or build, without understanding that dynamic behaviour

depends ultimately on optimum tyre footprint and slip angle behaviour being maintained.

And, whilst *blindingly* obvious, but nevertheless only too often overlooked, that footprint only works if it is in firm contact with the ground!

Some trailer markers (almost incredibly) still claim, 'trailer's don't need shock absorbers mate'. They argue that interleaf friction provides sufficient damping.

But it does so, crudely, insufficiently and *only* and less necessarily, on compression.

The problem-causing rebound is totally unrestrained - the spring leaves are not then in held sliding contact and release their energy like the sling shots that they are.

Weight Transfer

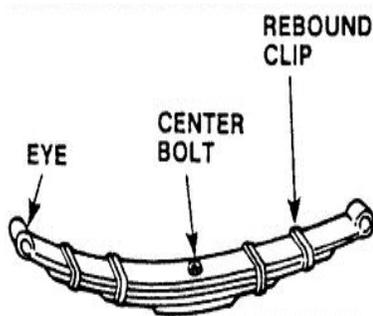
Because slip angles increase with load, and decrease with tyre pressure, higher loads require higher tyre pressures to restore/retain the required characteristics.

Side loads too affect tyre loading as more weight is transferred, via the suspension, to the outside tyres. If the tyre's weight balance is unchanged front/rear, front and rear slip angles simply increase proportionally and the vehicle's balance is maintained.

But if the tyre loading is substantially changed (front/rear) the relative slip angles change accordingly - to excess understeer (where the vehicle runs overly wide), or oversteer (where the vehicle either spins or hits something tail first).

The relative tyre loading front/rear (and hence slip angles) is not simply a function of weight distribution. It depends on how the suspension resists roll.

Stiffening the rear springs, or adding rear airbags only, transfers more of the roll resistance to the rear. This further loads up the outer rear tyre whilst cornering thus increasing its slip angle to the point where the footprint collapses, or slides, at a real risk of jack-knifing the rig. This is not theoretical conjecture: it can and does happen.



Leaf springs rub hard together on compression. The rebound clips do not provide enough friction to be of use on release. Shock absorbers are vital.

Roll stiffness is also changeable by varying anti-roll bar stiffness. Increasing front roll bar stiffness, for example, causes more of the roll couple to be resisted by the outer front tyres, thus increasing understeer.

The manufacturer's intended front/rear slip angle relationship should not be changed.

If the rear suspension is stiffened (or air bags fitted) so, and to the same degree, must be the front (or a stiffer roll bar added) to maintain the intended roll resistance balance.

Not doing this may result in a close to neutrally steering vehicle that is triggered into sudden oversteer by a suddenly swaying trailer. Such changes require serious engineering expertise.

Raising Suspension

A beam-axle 4WD

rolls about an axis about 700-800 mm above ground - a bit lower than the vehicle's centre of gravity. Lifting the suspension raises the centre of gravity relative to the roll centre - causing the body to roll a bit more about that axis. This increases tyre slip angles slightly, but generally equally.

Independent suspension front and rear results in a roll centre close to ground level.

This geometry causes the body to sway (like an inverted pendulum) about that ground level point resulting in sideways weight transference that increases slip angles, reducing ultimate cornering ability.

With independent front (but beam axle rear) suspension, front\ rear balance (and hence slip angles) will, if the suspension is raised, inevitably be altered.

It is, to put it mildly, difficult to sustain claims that suspension lifts do not degrade stability without suspending some of Newton's more fundamental laws.

The download on an overhung hitch causes the rear of a tow vehicle to be levered downward about its rear wheels, and the front lifted. This increases the rear slip angles and decreases those at the front (see Part 1).

The downweight causes the tow vehicle's rear to drop. Stiffening the rear springs or adding rear air bags alone, increases the rear roll resistance (*further* increasing the rear slip angle) and worsening the already undesirable weight transfer.

In the more severe instances, such rigs

are potentially mobile accidents waiting for the right triggering circumstance to occur.

A weight distributing hitch assists to remedy this by forming a semi-flexible beam between vehicle and trailer. This restores some of the imposed weight to the tow vehicle's front axle.

It is an essential component of any rig where the trailer is about 25% or so of the weight of the towing vehicle. Tow



Genuine pix of a donkey cart where excess rear load has hoisted the donkey completely off the ground - some caravaners deny this can happen!

ball weight is essential for stable caravan towing.

That commonly recommended in Australia, about 10% or the gross trailer weight, was arrived at 60-70 years ago - when most caravans were around 4.0 metres long and weighed 1200-1800 kg.

It has become virtually a mantra but is, at best, a rough guide for centre kitchen 'vans of the above sizes.

It is, with respect to many who so long promoted its use, based on a fundamental misunderstanding between weight and mass. (Much of the time those terms are interchangeable. In this context *they are not*).

Mass can be regarded as the amount of matter in something. The greater the mass, the greater the force needed to start or stop it moving.

Weight is simply a measure of the force exerted on a mass by gravity.

A hammer for example may weigh 1 kg, and can be rested on one's hand without concern. When swung, its mass is still 1 kg but the *force* that it exerts is many times more (the faster it strikes, the greater the force).

As a hammer shows (and is how it works!) the force required to *initiate* or *resist* movement of a mass increases with the rate of change of that mass's movement.

The down force exerted by gravity on a tow ball supporting a mass of 200 kg, will be that *only* whilst it is at rest.

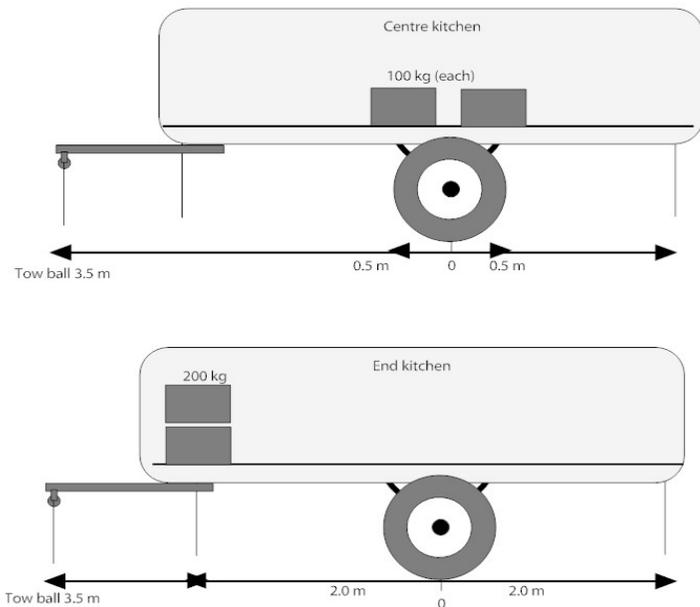
The forces exerted when the rig pitches

downward (or the tow vehicle upward) well exceeds that amount.

Such forces increase with the *square of the distance* that any so-moving mass is located from its centre of gravity. Thus a 250 kg mass on the tow ball of a *six metre* 'van exerts far greater dynamic forces when swaying, than does the same 250 kg mass

Conversely, 10% is far too low for a seven metre with the lot, but the 350 kg limit generally precludes more, unless the tow vehicle is (as one builder owns - or used to own) a cut-down Mack truck.

Or as with a well known tri-axle Bushtracker, about 1000 kg on the rear of a Dodge RAM.



These two trailers will behave very differently on-road. Moving the mass of that kitchen from the centre (where it had next to no effect), adds a huge amount of mass forward.

on the tow ball of a *four metre* van.

Likewise, does the mass of an end-kitchen, let alone a motorcycle slung on the rear.

(One can stand quite comfortably near the centre of a circus merry-go-round but, at the periphery one has to hang on for dear life simply to stay on board). Life is sometimes a bit like that too!

The 10% nose weight is thus *absurdly* too high for most camper trailers that, in practice, may range from 2% to 20% with no little or apparent noticeable effect. (It leaves one to suspect that the recommended weight is what it turned out to be when first made).

Similar effects and relationships apply to weight/mass when caravan or tow vehicle yaws (sways).

The forces are there, but the *resistance* to a mass's change of movement (inertia) may initially mask this effect - as for example a heavy tow vehicle tows and excessively end-heavy 'van. 'Steady as rock' - until that one day when

Swinging Pendulums

Conventional caravans and fifth wheelers behave quite differently.

A fifth wheeler and its tow vehicle is like

a horizontal pendulum of which the pivot is the tow vehicle and hitch, and the bob is the mass of the trailer.

Disturbing forces cause that mass to swing, but (with a fifth wheel trailer) the forces are mostly small and kept harmlessly in check.

Providing the rear wheels are well back, that the weight on the tow vehicle is within both vehicle's limits, and the hitch above or in front of the tow vehicle's axle (and allows the trailer to oscillate from side to side, rock fore and aft, and turn), no unduly disturbing loads are transferred from either part to the other.

A well-balanced fifth wheeler is stable,

and that stability is unrelated to speed.

If a hitch unduly restricts or (worse) precludes side/side movement however, a torsionally rigid fifth wheeler transfers roll resistance to its front and thus (unilaterally and primarily) to the towing vehicle's outer rear tyres. This increases their slip angle.

If it also results in the tow vehicle being moved sideways, the rig's behaviour may exhibit some of the swaying behaviour described below.

The same caravan-like behaviour may also manifest if the hitch is located to the rear of the tow vehicle's axle.

A caravan's behaviour is far more complex and right from the earliest usage (around 1920 onward) there have been ongoing reports of caravan-related accidents.

'Trailers, when towed at high speed often have a tendency to start swaying from side to side . . . (This) usually follows some sort of steering manoeuvre such as overtaking a vehicle on a motorway, or going round a sharp bend,' states Christopher Killer (Dynamics of Towed Vehicles, 2003).

He adds that, 'nearly all snaking accidents involve caravans.'

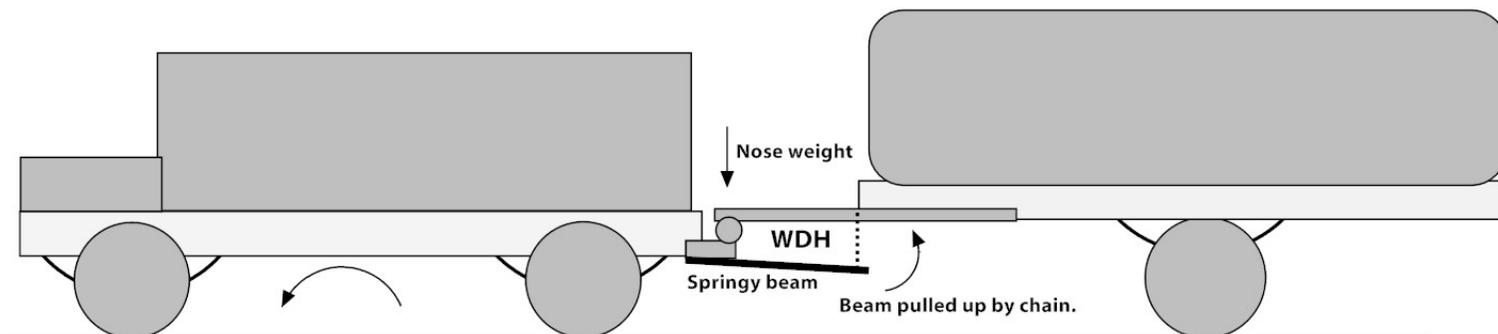
When a caravan sways, its transfers that sway, via an overhung hitch, to the tow vehicle. The transmitted forces are resisted by the inertia (i.e. resistance to movement) of the tow vehicle, and reacted by the grip of its tyres.

The caravan's wind drag and rolling resistance reduces the sway movement, but its (yawing) inertia causes it to overshoot. The oscillatory action may thus continue until the energy is somehow absorbed.

A similar action happens in reverse when the tow vehicle sways (and the two parts then interact).

Below a critical speed (specific to each rig) such swaying results in the energy expended automatically slowing the rig (typically by 10-15 km/h) and the interaction dies.

But if swaying occurs above that critical speed, the interacting energy may (and sometimes does) build up, generating forces



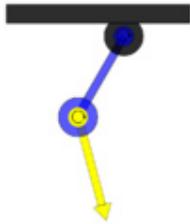
Weight distributing hitch (WDH) - a vital component for any but the lightest (<750 kg) trailers. The hitch in effect acts as a semi-flexible beam between the two vehicles. The (necessary) nose weight of the trailer pushing down on the tow acts as a lever and lifts the front wheels of the tow vehicle. In essence, a WDH levers them back down again pushed them back down again.

that exceed the ability of either or both parts of the rig's tyre's, let alone the driver's ability, to react.

The physical movement also suddenly changes - to that known to physicists as chaotic behaviour. If/when this occurs that rig is all but certain to jack-knife.

Theoretically, the tow vehicle and its overhung hitch form one pendulum, from the bob of which swings a second pendulum (the caravan).

Explaining the subsequent dynamic behaviour of such double (also known as complex) pendulums involves double



The double pendulum - a caravan sways like this. For a graphic working demonstration see:

http://www.myphysicslab.com/dbl_pendulum.html

differential equations. The action is shown dramatically however at (http://www.myphysicslab.com/dbl_pendulum.html) and includes the maths (that I do not even pretend to understand), for those so interested - and mathematically truly competent - which I am not.

A sanely designed, laden and driven rig is a safe combination. However as a few engineers, including myself, have long suspected, and The Department of Mechanical Engineering at the University of Bath recently confirmed, there are limiting conditions that, if ignored or exceeded, are likely to cause a caravan to go out of control.

Knowing this, and its probable causes, must surely however be preferable to caravans seemingly jack-knifing without apparent cause.

(This following web-reference is an interactive demonstration of this section.

It enables even the most doubting readers to test for themselves the effect of excess end weight (mass). <http://www.towingstabilitystudies.co.uk/stability-studies-game.php>

Try it - it shows the effect very clearly.

Speed - the Vital Factor

The generality of the above is known to be correct and quantifying and correlating the various causes and forces is well underway, but not yet totally established as there are innumerable uncontrollable variables, such as loading, and driving techniques, plus

roads and weather conditions.

Whilst a mildly snaking rig normally corrects itself (the often-suggested minor acceleration is risky), ongoing and repeated controlled trials *strongly* indicate there is a critical limiting speed for *any* specific combination of tow vehicle and caravan.

Above that limit which, if snaking is triggered, that snaking *irreversibly* escalates and/or snaps into chaotic behaviour.

It has been conclusively shown that speeds at which this may occur typically begin at not that much over 100 km/h.

That speed is directly associated with the 'van's length and weight distribution, with both vertical and lateral disturbing forces (i.e. pitching and yawing) increasing as speed increases.

A study by Darling, J., Tilley, D., Gao, B., 2009. 'An experimental investigation of car-trailer high-speed stability' published in the *Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering*, 223 (4), pp. 471-484) indicates that dominant factors affecting stability are trailer yaw inertia, nose mass (mass distribution), and trailer axle position.

Tyre pressure too also affects stability, although less significantly.

There is increasing evidence that wind speed as well as road speed is a limiting factor and that driving fast when there is a strong side and/or head wind is not advisable.

It has often even been suggested that a wind-speed indicator be used when towing where a rig has only border-line stability.

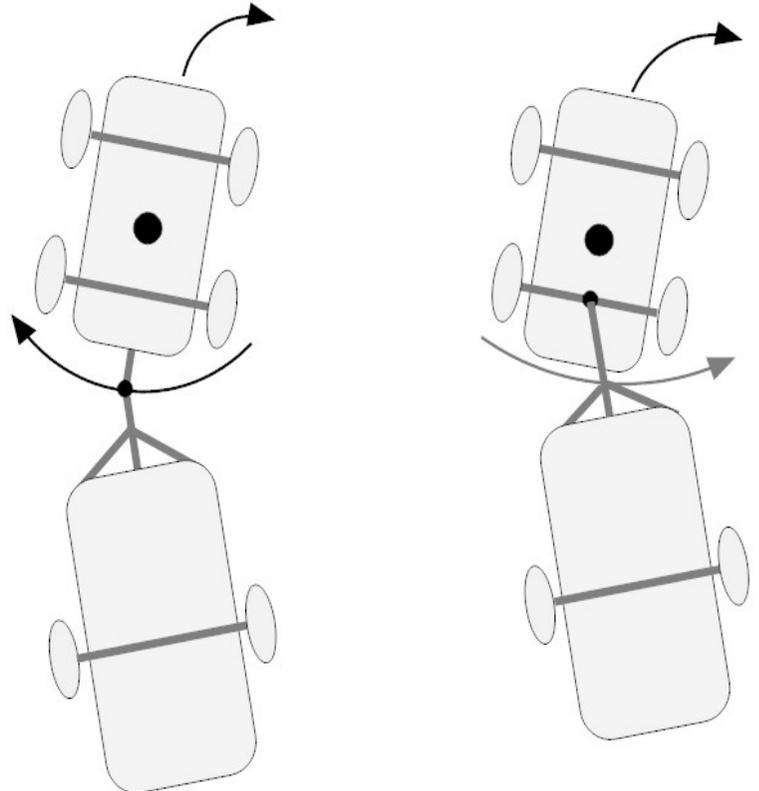
Optimising Towing Stability

Tow vehicle behaviour is now well understood, both in theory and practice. A long wheelbase tow vehicle with short

rear overhang, and that weighs more than the trailer, is more stable than one that lacks such attributes. Lateral deflexion of the tow vehicle's rear tyres is also a factor.

Much is now known too about caravan stability but, because most of the information is almost entirely in academic papers (albeit confirmed by practical testing), little is currently being applied except by companies such as AI-KO in Europe - and hopefully this article.

In essence, reducing trailer perimeter



Caravans and fifth wheelers different dynamic behaviour. A caravan's overhung hitch imposes a double pendulum effect that fundamentally precludes predictable behaviour beyond a critical speed, weight and length-related disturbance. A fifth wheeler behaves predictably (as a simple pendulum at all speeds. If however that hitch is behind the axle, it behaves as a (double pendulum caravan - but to lesser extent).

and particularly end-weight/s is vital. 'A fast moving caravan with a large mass distributed around the perimeter would be highly unstable', states Chris Killer.

Further, long caravans need long and heavy vehicles to tow them.

It makes every sense to follow European practice of locating the spare wheel/s on a carrier below the chassis and in front of or behind the axle.

Batteries should be located centrally between the axles. Ideally water tanks should be long but narrow and located as centrally as possible..

A friction layer around the hitch has been shown to smooth down minor snaking, to

reduce settling time. Trials however show that such (Coulomb friction) devices have no effect on forces beyond that.

The author at least, is concerned that the restraining forces built up within such devices, add suddenly and possibly dangerously to the disturbing forces, when such devices are suddenly overwhelmed - and let go.

Automatic Stability Control

Within reason, a swaying caravan is controllable by selectively and



Above: How the AL KO stabiliser works.
Pix: Courtesy AL KO Europe.

proportionately applying ONLY its own brakes. AL-KO (in Europe) agrees that towed caravans exhibit the 'critical speed' referred to above, and that *differential* 'van braking' is a solution.

The company has developed an ATC Trailer Control electronic control system that reacts quickly to restore stability.

This unit continually monitors the stability of the caravan and operates *only* when a potentially dangerously unstable condition is detected.

It does this via sensors on the caravan that detect laterally disturbing forces (such as a large swinging motion - but ignore bends etc) and, via a servo mechanism, applies the appropriate side *caravan* brake/s only, *selectively and appropriately just before instability becomes critical*.

The system is claimed to raise the critical speed by about 20%, but the makers sensibly warn it is an emergency aid intended to operate *only* to prevent an accident.

It is *not*, stresses AL KO, a way of enhancing stability. Curiously little appears to be known locally about this major development, but this possibly because the units so far cannot handle the sheer mass of most local products.

Conclusion

A long end-heavy caravan commonly feels more stable than a short one with centralised mass (short twin-axled 'vans are usually very stable but often feel 'twitchy' due to their fast but minor movements), but such impressions are illusory.

Inertia is not the same thing at all as inherent stability: a giant container ships seems ultra-stable - until a rogue wave rolls it too far - and its inertia keeps it rolling).

"My mega-van always seemed rock stable until the day it jack knived and rolled over" is a very common post-accident reflection.

I suspect further research will result in long end-heavy caravans being relics of the past, not least because, over a certain length (that I suspect to be about six metres) the fifth wheel configuration dynamically makes so much more sense.

There is also increasing evidence that the probable safe speed for big rigs is less than the limit of 100 km/h.

Having researched this issue in depth for the past 10 or more years I would not personally tow any conventional caravan longer than five metres at over 90 km/h, unless built in accord with the generality of this article.

And even then, not at over 100 km/h, even were laws to permit.

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The AL KO stabilising unit fitted to a European caravan. It works automatically at lighting speed - braking one of the other wheel as required to counteract the swinging forces as they arise - and by slowing the rig reduce the energy involved. Pix: courtesy of AL KO.



Maurice Olley (1889-1972)

Maurice Olley was born in Yorkshire, coincident with that of the first automobiles.

Following a time with Rolls-Royce he moved to the USA to work with General Motors Research Division, later returning to Vauxhall Motors in Bedfordshire.

I was privileged to attend his lectures during his time with Vauxhall Motor's Research Laboratory. I am also fortunate enough to have a copy of his extraordinary (engineer-oriented) 620-page *Chassis Design: Principles and Analysis* published many years later (and sadly well after his death in 1972).

I dedicate this article to Maurice Olley. I wish to fully acknowledge that this article would not have been possible without the theoretical and practical background laid down so brilliantly in the USA, some 70 years ago by this highly talented British engineer.

It was a very genuine privilege to have known him and to have access to his work.

Collyn Rivers (1930)

Originally an RAF ground radar engineer, after a two years with de Havilland working on guided missile power systems, Collyn worked with Vauxhall Motors Research Laboratory - on all manner of passenger and truck research and development.

During 1959 - 1960, he drove a big 4WD Bedford twice the length and breadth of Africa (including two Saharan crossings).

Collyn moved to Australia in 1963 where he designed and built scientific measuring equipment, and for a few years was Applications Engineering Manager of Natronics Pty Ltd.

1970, he changed career to found what he built into the world's largest circulation electronics publication (*Electronics Today International*) in seven different countries.

In 1976, the Australian edition was acclaimed, by the UPRIEE, as the 'world's best electronics journal.'

Collyn went on to publish many other publications in areas of science and technology.

From 1982-1990 he was technology editor of *The Bulletin*. He later wrote and produced Telstra's respected *Telstra Consultant* quarterly, and also founded (in 1986) the *Australian Telecommunications*.

He still writes and publishes books on all aspects of RV and solar usage.

One, *Motorhome Electrics - and Caravans Too* has since become Australia's standard text on this subject and has signs of becoming so worldwide; his two current solar titles are also achieving this status.

These books are available from all Jaycar stores Australia-wide).

When doing nothing else, Collyn reads a lot of books and rides a unicycle.

Some years ago, the Sydney Morning Herald described Collyn as being 'one of the last Renaissance men'.

An (outspokenly) independent biography may be found at:

http://www.caravanandmotorhomebooks.com/about_the_author.html

