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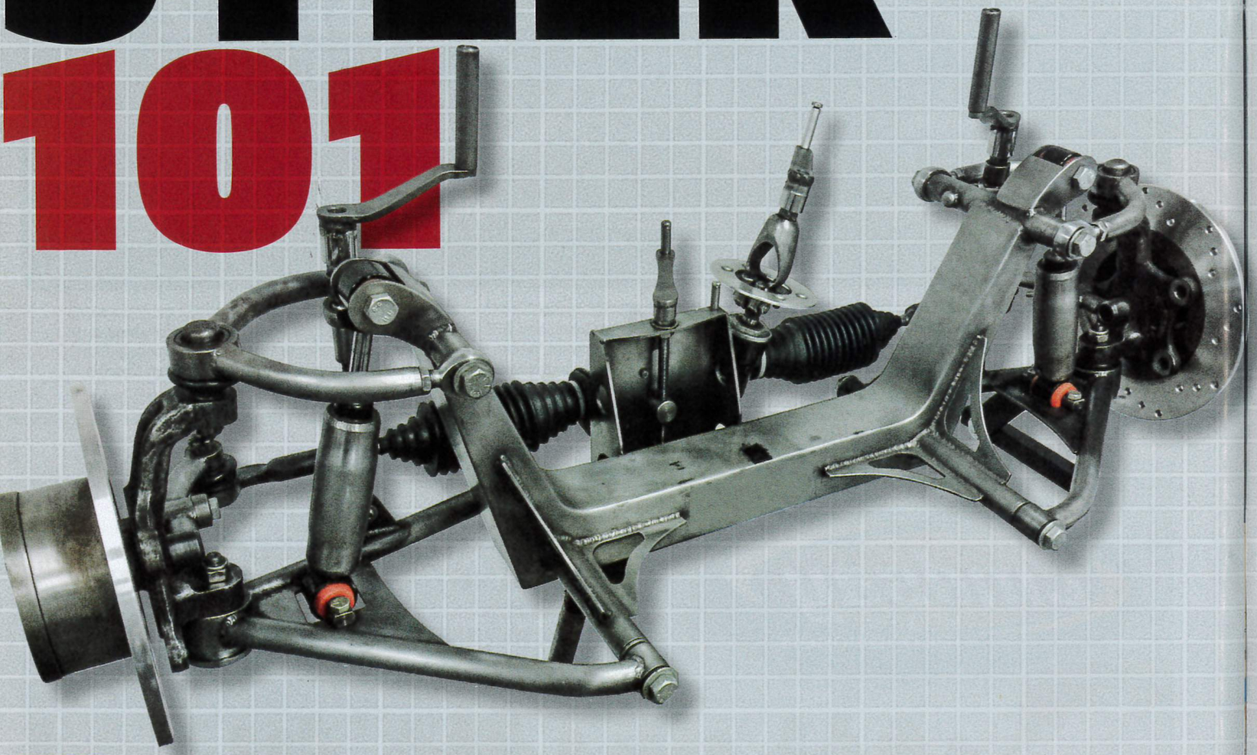
BUMP STEER 101

WHAT EXACTLY IS 'BUMP STEER'? WHY'S IT SO BAD, AND HOW CAN YOU FIX IT? WE FIND OUT!



Nowadays, it seems that bump steer is at the forefront of vehicle safety in the custom and aftermarket realms, and rightly so. But what actually is 'bump steer'?

In effect, it is exactly what it sounds like — a change in steering geometry resulting from a vehicle's suspension moving through its normal range of travel. While it is almost impossible to set up a vehicle's steering geometry for zero bump steer, it is desirable to have as close to none as can be achieved, due to its potential for dangerous and unpredictable steering characteristics.

Bump steer is usually due to the relationship of the steering arms with the suspension arms, as each go through their arc of movement. The position of the inner steering-arm joints (the steering-rack end) may have the steering and suspension arcs being different, which causes the steering to toe in or out as the suspension goes through its travel.

Essentially, steering-rack position is the key to correcting, or minimizing, bump steer, and changes in rack height or forward/aft location of just a few millimetres can have a big impact on the final result — yes, small changes are that critical.

What's concerning, though, is that there's a number of well-known aftermarket suspension manufacturers that sell complete replacement front ends that have no consideration for bump steer or use countermeasures to mask major avoidable design flaws.

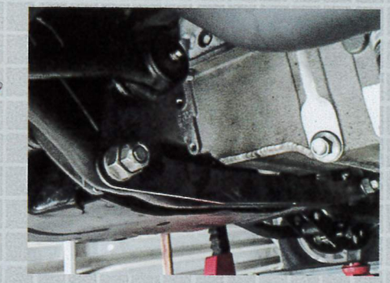
In New Zealand, any custom-geometry front-suspension design is required to be LVV certified, and, as such, must meet acceptable bump-steer requirements. Ironically, it's feedback from the assessment of some front-suspension systems that has gone back to manufacturers that have, in turn, seen them change their designs. Nice work, New Zealand.

Let's say a vehicle toes in on compression and out on extension. Think about what happens when one wheel goes up and the other goes down, when the road is undulating. Instead of wanting to travel forward, the car is going to want to turn, despite the steering wheel staying straight.

Of course, it doesn't need to be a bump on a straight piece of road; cornering loads can have the exact same result. It sounds dramatic, but the straight-road-bump-steer scenario is exactly what was responsible for a death a few years ago, when a Subaru Impreza, fitted with a Lexus V8, left the road at high speed. The vehicle, which was known to be a handful to drive, had been subject to many wheel alignments to try to tame it, but not once did anyone notice the fact that the steering rack had been lowered to allow for the replacement engine to be fitted.

While there can be some visual clues — to the informed — a static check of a vehicle will not reveal bump steer. Instead, it must be run through its suspension travel, be that via a pull-down bump-steer test on a wheel-alignment machine or a bump-steer swing check.

While the results for the same vehicle tested both ways will vary a fraction — generally due to the movement in suspension bushes more than anything else — the results will trend the same way when plotted out onto graph paper or similar.



PRACTICAL EXAMPLE

DAMIEN CROOK — 1968 CHEV CAMARO

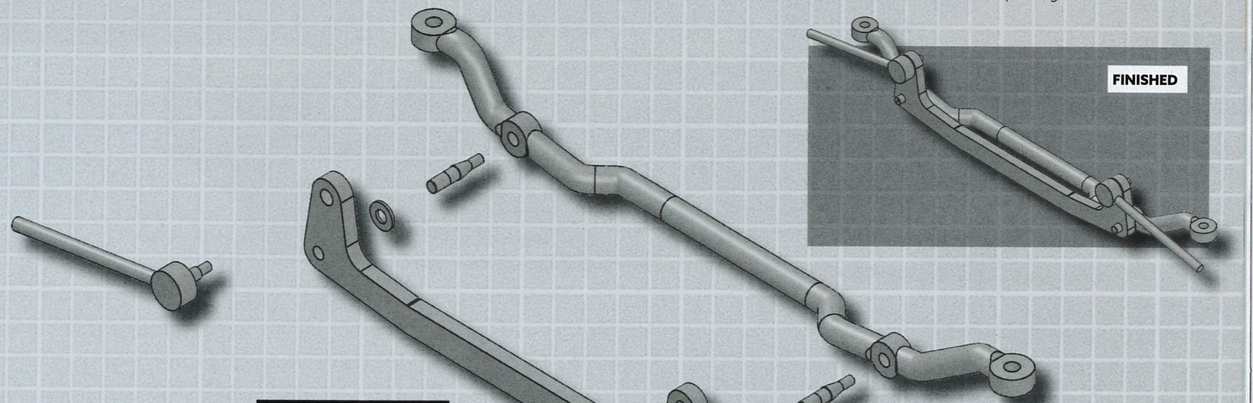
During the build of his pro-touring '68 Camaro, Damien Crook purchased a bunch of Ridetech steering and suspension gear, primarily because he thought that the kit would all but eliminate bump steer. Further testing found this not to be the case. The Ridetech kit utilizes a secondary drag link that bolts to the factory drag link through the tie-rod points and raises the tie-rod pickup points.

To try to achieve desired bump-steer figures, with the advice of his LVV Certifier, Damien laser-cut several test jigs — with multiple tie-rod pickup points — to experiment with what would yield desirable bump-steer characteristics.

The knowledge gained through this test allowed Damien to design and laser-cut a functional replacement secondary drag link that reduced bump steer to a minimum, well below the 10mm maximum allowed. Keep in mind that he probably could have done this by hand, but, with access to the right tools, he figured that he'd go all out.

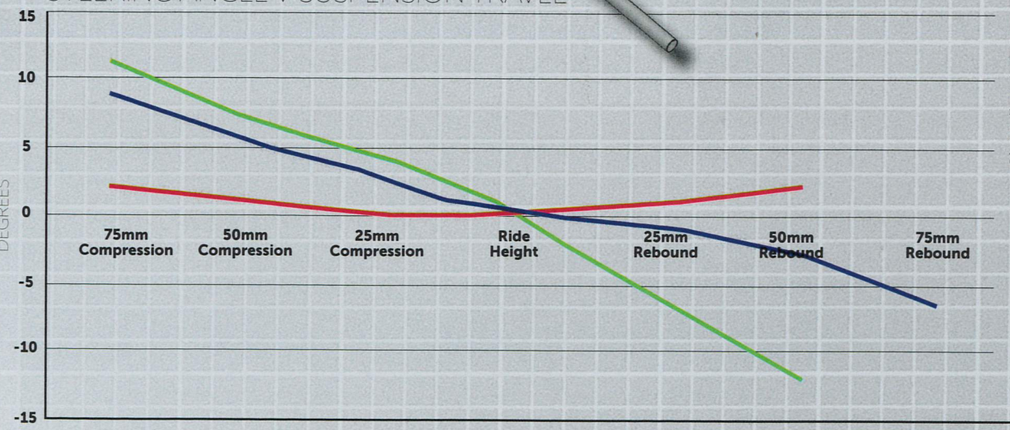
"I think the problem lies with how Ridetech developed the product," Damien explains. "If you don't have the exact same set-up they did, your results will be well off. For me, I think the changes to ride height influenced the bump-steer results the most. I have raised my car 25mm higher than their set-up, as I wanted plenty of road clearance and drivability on New Zealand roads."

The graph shown plots steering changes (vertical) against suspension compression and rebound for the stock steering, Ridetech unit, and Damien's concept drag link. As you can see, a brand name doesn't guarantee that a new component will impart improved performance over the stock unit it is replacing. >



BUMP STEER GRAPH

STEERING ANGLE V SUSPENSION TRAVEL



BY MEASURING HIS STEERING ANGLE AT VARIOUS LEVELS OF SUSPENSION TRAVEL, DAMIEN WAS ABLE TO PLOT THESE BUMP-STEER GRAPHS AT EACH DEVELOPMENT STAGE. WE CAN SEE THAT BUMP-STEER WORSENED AFTER INSTALLATION OF THE RIDETECH SUBFRAME, BUT HIS SECONDARY DRAG LINK BROUGHT IT BACK TO AN ACCEPTABLE LEVEL – AS CLOSE TO ZERO AS FEASIBLE

WHAT DO I **LOOK FOR?**

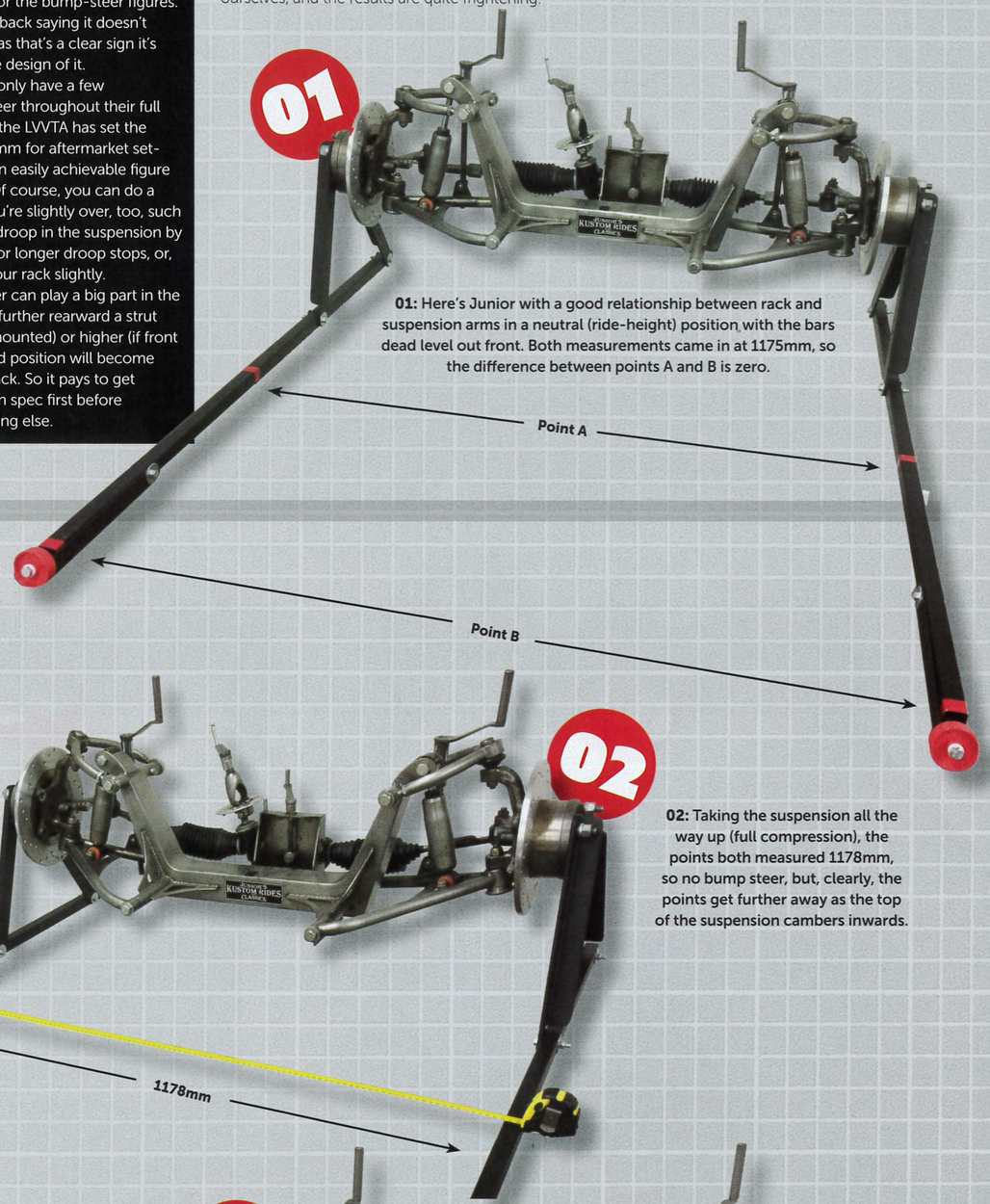
If you're looking at purchasing an aftermarket front clip (including rack), when possible, ask the company supplying it for the bump-steer figures. If the company comes back saying it doesn't know, then run a mile, as that's a clear sign it's put no thought into the design of it.

Most modern vehicles only have a few millimetres of bump steer throughout their full suspension range, and the LVVTA has set the acceptable limits at 10mm for aftermarket set-ups, which should be an easily achievable figure with the right design. Of course, you can do a few things to help if you're slightly over, too, such as limit the amount of droop in the suspension by adding shorter shocks or longer droop stops, or, as mentioned, space your rack slightly.

Keep in mind that caster can play a big part in the adjustment too, as the further rearward a strut tilts, the lower (if rear mounted) or higher (if front facing) the outer tie-rod position will become in comparison to the rack. So it pays to get your wheel alignment in spec first before you go tweaking anything else.

THE VISUAL EXAMPLE

This front-end jig, dubbed 'Junior', was designed specifically to demonstrate the concept of bump steer and is used by the LVVTA as an educational tool. We got access to Junior to have a play ourselves, and the results are quite frightening.



01: Here's Junior with a good relationship between rack and suspension arms in a neutral (ride-height) position with the bars dead level out front. Both measurements came in at 1175mm, so the difference between points A and B is zero.

02: Taking the suspension all the way up (full compression), the points both measured 1178mm, so no bump steer, but, clearly, the points get further away as the top of the suspension cambers inwards.

03: Now we take the suspension all the way into full droop, and the bars are 1164mm apart at both points. So, over our full range of travel, the difference between the bar width is still zero, meaning no bump steer at all — a sign of a perfect set-up. >

WHAT ABOUT ME?

So, what do you do if you're fitting a steering rack to your car in place of a steering box? The best idea is to try to get the rack sitting as close as possible to a neutral position, both up and down, and front to back. Obviously, real-world issues, such as cross-member and engine-sump placement generally limit the location, but the best plan would be to get it sitting roughly right. Then, as Damien did, run a DIY bump-steer test. While you can go all out for this with a proper bump-steer kit, you can also use a few G-clamps or vice grips, clamping bars, or any straight object on your brake discs. Ideally, though, the bars should sit at the same height as the bottom of the tyre. When you run the car through the travel, you'll soon see the effect the rack position has.

If it's giving more than 10mm of bump steer, try spacing the rack out, maybe a few washers or spacers under, or behind, it. Keep playing like this until you've got as little bump steer as possible. While the shape of the bump-steer line plotted out will give an indication of where the issue lies, that's a bit too technical for us to include here, but worth looking into if you're interested.

If, however, you still have no luck with your rack position, there is another way, as previous feature-car owner Jim McIndoe found out. The aftermarket K-member fitted to his Cuda had big spacers between the tie-rod ends and the hubs, which is a no-no and, essentially, a cover-up for a poor relationship between the rack and the steering arms. But Jim simply found a production spindle that he could bolt up instead, moving the tie-rod points to the perfect position. They weren't anything exotic, either — simply off a Nissan Navara!

HOW TO **TEST FOR BUMP STEER**

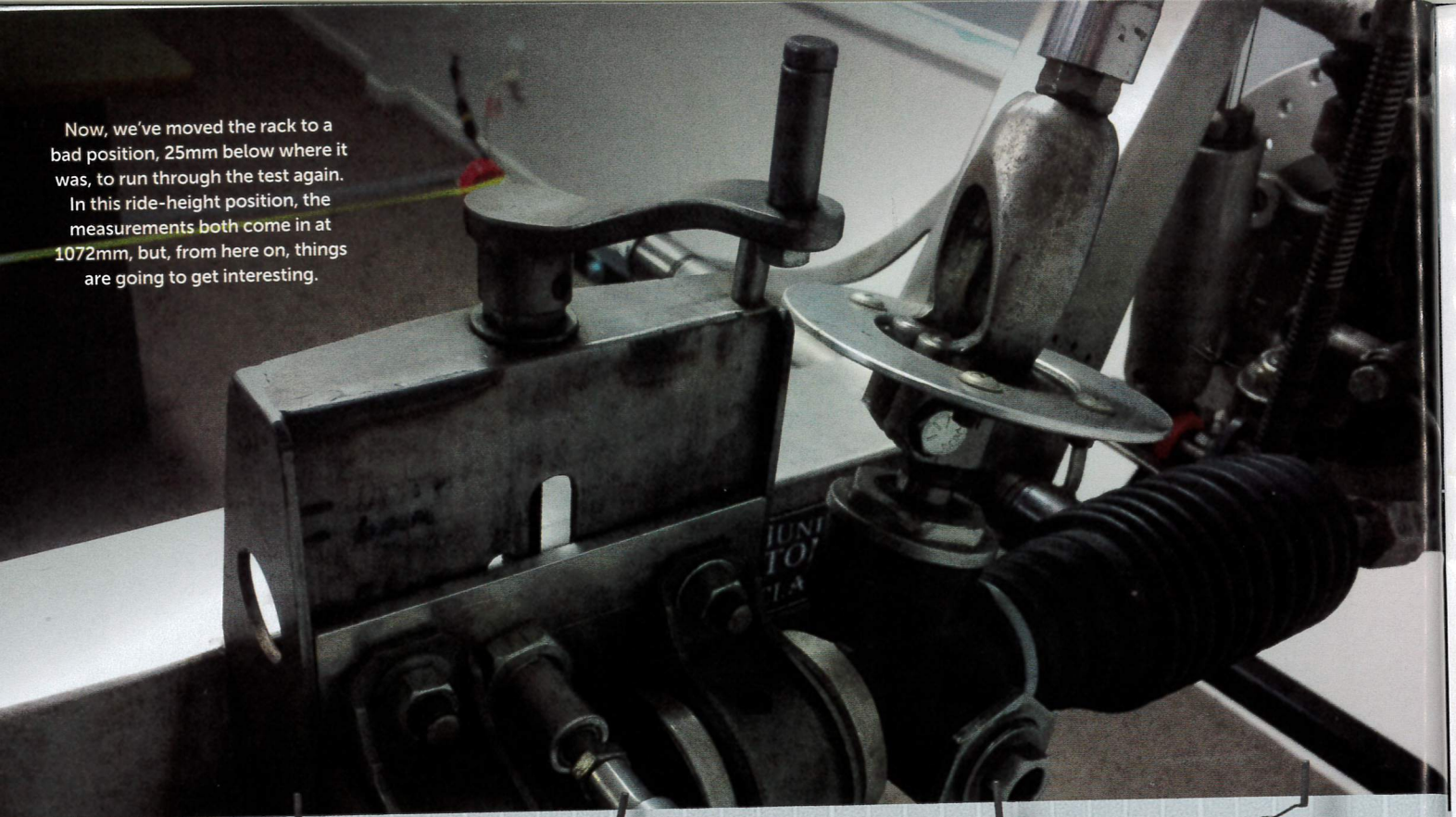
While there are specialist bump-steer bars available, in most home situations, you can simply get a wheel-alignment specialist to perform a pull-down test, or you can alternatively make your own bars. Those which LVV certifiers use measure 1265mm end to end and have two points marked on them, point A at the far end from the hub and point B, 575mm closer.

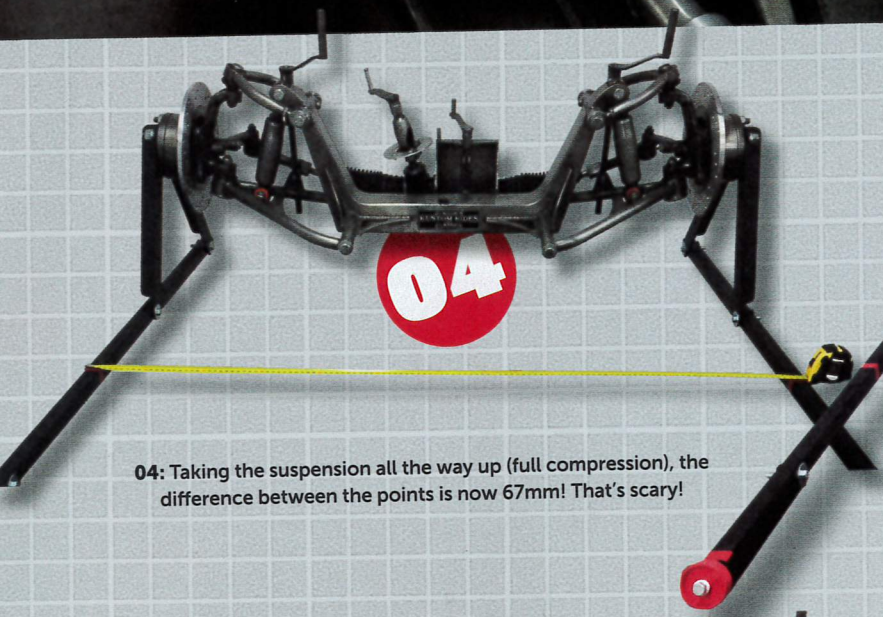
The A and B marks are a guide to locate the tape measure when reading toe, the 575mm measurement being representative of an average tyre diameter. This also makes it simple to convert between degrees and millimetres, as a 575mm distance always gives a 10:1 ratio of millimetres to degrees. So, when the toe on the bars measures 10mm, this equals one degree of toe.

At home, you can run some bars straight off the hub; although, to make it the same as what your certifier will subject the car to, in theory, they should be around 300mm below the axle line.

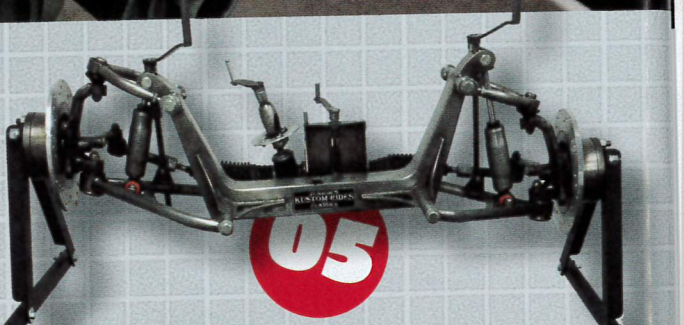
Your zero point is at unladen ride height, and, from here, you'll need to jack the wheels up (equally) and take measurements every 20mm or so, measuring the distance between point A on the left bar and point A on the right bar, and the same for point B (that's A–A and B–B). Note the numbers down as you go, as it's the difference between these figures that is the value you're looking for. Once you've gone all the way up to the bump stops, let the wheels droop down, again taking measurements every 20mm or so as you go. If you measure the ride height at the same time, you'll have no problem plotting the figures. You should be able to plot the results on some graph paper and calculate the total change from full droop to full compression.

Now, we've moved the rack to a bad position, 25mm below where it was, to run through the test again. In this ride-height position, the measurements both come in at 1072mm, but, from here on, things are going to get interesting.

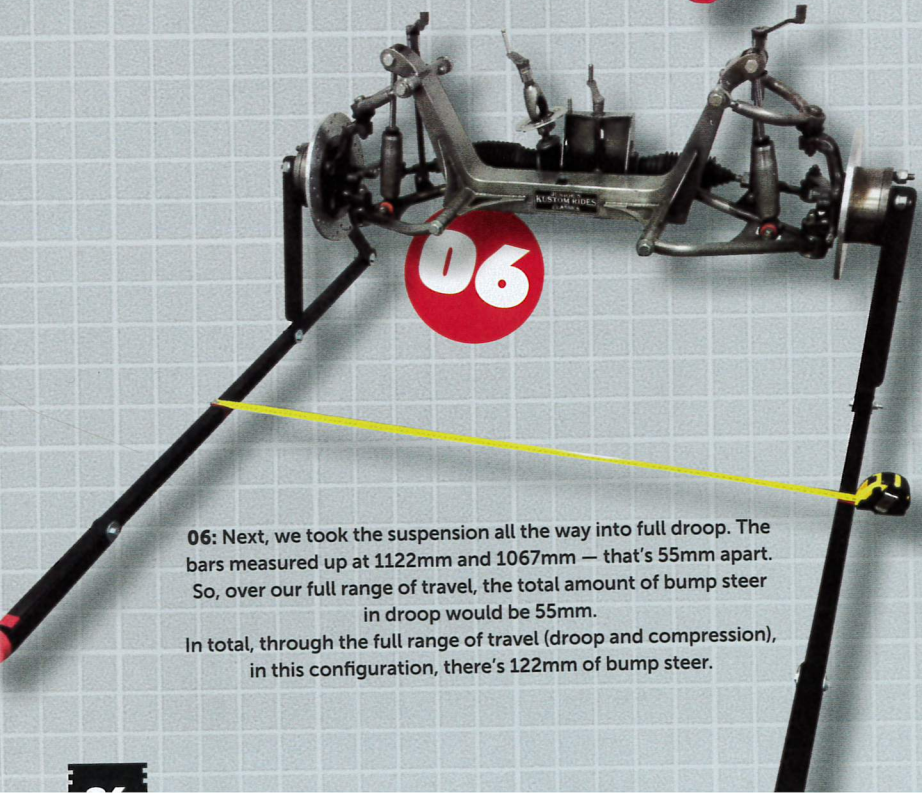




04: Taking the suspension all the way up (full compression), the difference between the points is now 67mm! That's scary!



05: Although hard to see, this shot shows one wheel at full compression and the other at full droop. While we didn't take a measurement at this setting, a vehicle would feel all shades of wrong if it had a set-up like this.



06: Next, we took the suspension all the way into full droop. The bars measured up at 1122mm and 1067mm — that's 55mm apart. So, over our full range of travel, the total amount of bump steer in droop would be 55mm.
In total, through the full range of travel (droop and compression), in this configuration, there's 122mm of bump steer.

THE **IDEAL WORLD**

In an ideal world, cars would have zero bump steer, like Junior did with the rack set up correctly, but, unless you're designing a car from scratch with this as the key concept, it's not that easy to achieve. However, vehicles such as Formula 1 cars have exactly that, and many street cars have just a millimetre or so, so it can be achieved.

THE **REAL WORLD**

Here's a chassis that was built locally a few years ago. It was far from compliant, and offers a very visual real-world example of what bump steer looks like. V8