EVO SEPT 2014

THE FALL AND RISE

ELECTRIC POWER STEERING HAS LEFT MANY A CAR WITH 'NUMB'

We like to feel the road through the steering. That's a given for a keen driver. But what exactly is it that we're feeling?

What we want to feel is a changing force which confirms that the car is going where we have told it to go and how much grip we have left. It gives us confidence. However, what we think of as 'feel' might be nothing of the kind, and instead be merely an artificial recreation of what makes us feel confident behind the steering wheel.

Things have come to a head with the increasing adoption of electric power steering. With unassisted steering, all the turning effort comes from you, and an indication of other forces acting on the front wheels is fed back to you. With hydraulic power steering (HPAS), a hydraulic ram assists your efforts; the more torque you apply to the steering wheel, the more you twist the torsion bar that forms the base of the column and the further a hydraulic valve is opened to allow more assistance pressure. You supply the effort, the power assistance boosts it.

Electric power steering (EPAS) is different. The way it works has forced engineers to analyse the components of steering feel like never before, so the right ones – on which opinions vary widely – can be synthesised in a system unable to provide detailed natural feel (see panel below).

What, then, creates this feel and feedback that we are losing? Matthew Taylor, vehicle dynamics engineer at Prodrive, has cogent views on the subject: 'Steering feel is the only aspect of vehicle dynamics on which the experts disagree. Nothing else is as subjective.'

R26 proved that decent feedback from electric power steering systems is possible

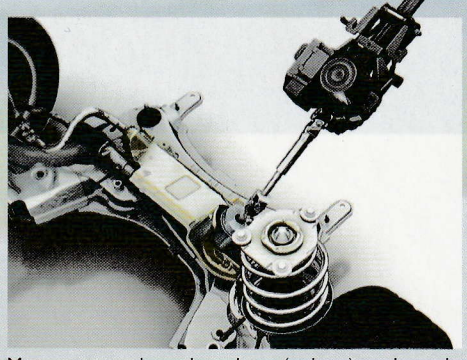
He divides philosophies on steering feel into two camps. Camp A is not just the information you *need* but also the information you *want*, associating the car with the road. Camp B communicates what you need, but everything else is removed as merely constituting 'noise'. A Porsche 911 or a Jaguar is in A; an Audi is in B. A rally driver would favour A; a racing driver, driving repeatedly over the same ground, would favour B.

'I was called in to arbitrate between Mercedes and McLaren,' Taylor recalls. 'They were using a touring-car race driver to tune the SLR's steering. McLaren said it was dead and horrible, Mercedes said it was nice and meaty. The car was tricky near the limit and the steering made it more so.'

It was an extreme case of a 'B' car. In such a car, 'primary' steering feel is the sole aim, a feel based simply on steering weight which should increase with lateral acceleration or cornering force. It comes from the castor angle of the front wheels (the angle of the suspension relative to vertical), from the trail distance (how far the centre of the tyre's contact patch is behind the steering axis) and how positively the rear wheels are laterally located.

So, what does an 'A' car bring to the party? Typically it will have less castor or trail and less power assistance to overcome it, so more information can be fed back to the driver through the steering, and the subtleties of grip become more apparent. This is where the tyres' self-aligning torque comes in, the desire of a tyre to pull itself

How EPAS works


Motor may work on the column (as here) or the rack

Why can't electric power steering provide the same level of feedback and detail as a hydraulic system? Because instead of responding to a force, it responds to movement. As soon as the steering wheel is turned, an electric motor's worm gear turns either a gear attached to the column or a second pinion which meshes with the rack in the same way as the pinion at the bottom of the column does.

The direct link between your force and the assistance force is gone. Imagine you're pushing an object across a table. With HPAS, an assistance force helps push your arm. With EPAS, the object's movement is sensed and the object is then pulled away from you.

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OF STEERING FEEL

STEERING. **JOHN SIMISTER** FINDS OUT WHY, AND LOOKS AT HOW THINGS MAY IMPROVE

'STEERING FEEL HAS BEEN ANALYSED LIKE NEVER BEFORE'

straight so its tread isn't being scuffed.

When the grip is approaching the limit, the tread is starting to slip and the self-aligning torque is reduced, which you feel as a lightening of steering effort. You might also feel tugs at the wheel over cambers, or nudges over bumps, impulses of information strong enough to get past the dampening effect of a reduced-strength power steering system. You have proper steering feel, in fact, a tactile picture of the road beneath.

That's with HPAS (or no-PAS), of course. Given the right geometry, could EPAS do the same? Matthew Taylor was involved with the Renault Mégane R26, a car which showed that EPAS needn't be a disaster. 'We altered the system to allow the worm gear to float. So for small movements the feedback came back as there was no assistance around the centre.'

The R26 system also overcame the glutinous feeling many EPAS systems have when returning to centre, caused by the rotational inertia of the motor and the inefficient 'reversability' of the worm gear. Paris-based Nexteer, a major industry EPAS supplier, has further honed the idea with its active-return system as fitted to, among others, the new Citroën DS3. It uses software to emulate, as far as possible, natural self-centring.

Done well, such a system feels fine to most drivers, but it's still a Camp B approach with little scope for the transmission of subtle grip-change forces. Does it matter? It's similar to the manual-versus-paddleshift argument. And yes, it does.