THE SIMPLE SOLUTION

Is often the best one. One example is provided in the development that's taken place in anti-roll bar design. Feeding the suspension loads directly improves response, as John Miles explains

Apart from styling, suspension development is probably the last facet of car design where subjective methods are used to get the required result. I do not know of a computer or ride and handling 'meter' that can do anything more than assist the development engineer using his experience, persistence, and 'seat of the pants' feel. He has the picture in his mind of what the car should behave like. Over the years he gains experience in the infinitely variable interaction between springs, anti-roll bars, dampers, compliance, and, most importantly tyres, plus the likely 'value' of each tuning change. The most difficult element is usually to identify the key elements necessary to start the improvement process. The easiest and most dire trap to fall into is to pile fix upon fix, when a simple key change would do.

The fact is that experience still has a large part to play in development. Moreover, as fast as manufacturers talk of new highly sophisticated suspension systems (my view is that fully active ride is the only route that will take us into the 21st century), so engineers find clever ways of improving the admittedly very compromised conventional systems.

One such example has been the quiet revolution taking place in the matter of roll control. It concerns the strut-attached anti-roll bar systems that are rapidly becoming universal as new models appear. Excessive body roll is bad news. For the average driver it reduces his sense of security and confidence in the car. The more body movement taking place during cornering or 'lane change' manoeuvres, the more driver control and response will be inhibited by the momentum of body movement and by the effects that body roll must have on suspension geometries.

Although Mercedes may have been working on a similar system, credit for the concept must go to one Mike Foxon, who mooted the idea during the development of the Sunbeam Lotus. He first applied it when working as a contract engineer at Volvo. The results were dramatic. Good news seems to spread fast in motor industry drawing offices, and now if you look under models from Peugeot, Citroën (the AX), Opel/Vauxhall, BMW, Volvo, Toyota, probably several more, there is the system to be seen. (Ford cannot use it since the anti-roll bar forms an integral part of the lower link).

As the diagrams show, the anti-roll bar is mounted to the chassis/body in the normal way, but instead of being connected typically to the lower wishbone via a rubber bushed lineage, a double ball jointed link connects the end of the anti-roll bar direct to a bracket on the strut. The only theoretical disadvantage concerns the fact that as the strut rotates it will twist the anti-roll bar. In fact if the bracket position is optimised and the link length kept as long as possible this only happens on extremes of lock, and in practice the maximum steering induced twist is usually limited to 5mm while at all normal driving lock angles (10 deg at most) the problem does not exist.

Fully to understand the gains, it is important to realise that anti-roll bar systems on passenger cars very rarely limit ultimate roll very much. This job is done by the bump stop or more commonly found microcellular polyurethane 'spring aids'. Anti-roll bars are used to limit roll in normal driving and reduce the rate of roll (just as damping does), thus giving better transient stability. They can be used to limit ultimate roll, but are then likely to be so stiff as to cause problems with ride (single wheel bump inputs) and traction, particularly on bumpy roads, due to the fact that roll control is achieved at the expense of weight transferring on to the outside wheel (and away from the inside wheel). A steep rise in single wheel spring rate also causes more wheel hop. Excessively stiff ARBs are also a recipe for skittish behaviour on wet roads.

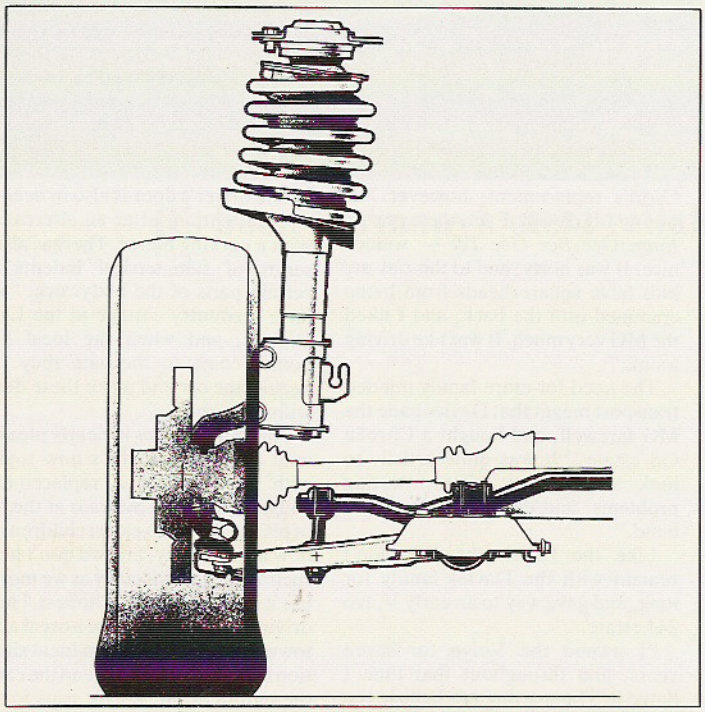
By connecting the ARB directly to the strut (or if possible to the front upright of a wishbone suspension) the gains are fairly obvious. For a start the roll bar is no longer working through a rubber bushed linkage. Secondly, it is working close to a 1 to 1 ratio with the road wheel. Both these elements improve response.

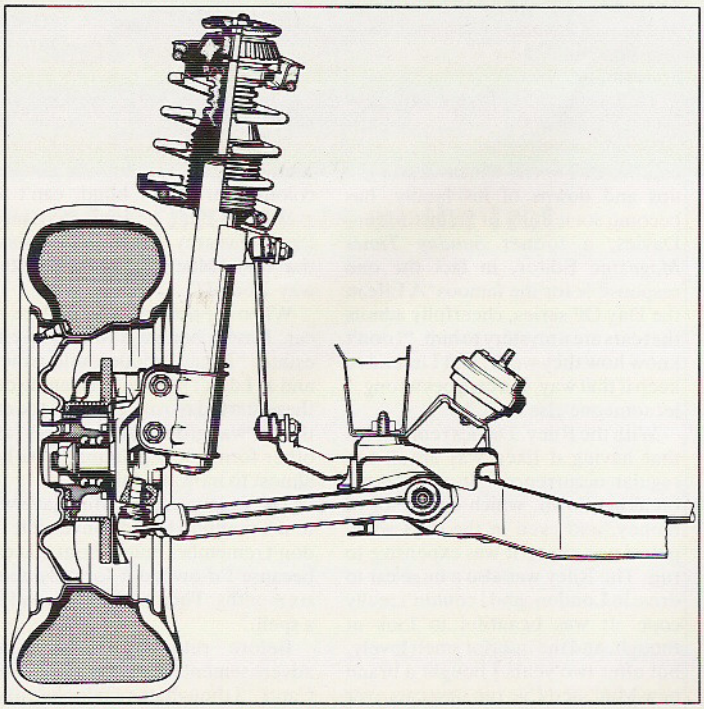
When the driver puts an input into the steering, the anti-roll bar reacts immediately. If a wind gust hits the car the body movement is arrested immediately — before the momentum can build up. It follows that there is much more linear behaviour in the system (and car), because the slop in the rubbers no longer has to be taken up before the anti-roll bar takes full effect. Furthermore — and most importantly — there is the prospect of *reducing* anti-roll bar size (and weight) while increasing roll stiffness. Smaller diameter anti-roll bars mean lower loads in the rubber bushes on the chassis.

I can give one classic example: a high-powered version of a medium size hatchback car appeared for tuning at Lotus with a front anti-roll bar of no less than 32mm diameter (weighting 7kg). Most of the twist can have only taken place in the rubbers since the forward pointing 'link' length was approximately 8ins. This was replaced by a strut-attached bar of 20mm dia scaling 3½kg. Subjective tests demonstrated an immediate improvement in roll control. Chassis rig measurements conducted later showed that the roll stiffness had improved from 750lb ft/deg to no less than 1050lb ft per deg. Furthermore, the linear relationship between anti-roll bar twist and wheel movement (lack of initial slop) enabled this improvement in roll control to be obtained without any sacrifice in ride quality. Nobody could have predicted just how effective this apparently minor 'tweak' would be.

Little of this would have been possible without some rather elegant links made by TRW Ehrenreich. At each end of the slender rod are some beautifully engineered sealed-for-life ball joints which will articulate through 60 deg and comfortably accept loads up to 1000lb.

The whole system is simple and elegant. Like all good designs we now stand back and say "why didn't I think of that . . ."





Traditional *roll-bar mounting (left) is giving way to direct mounting to the strut (right)*