Mallock Racing

September '86

Trailing Arm Magic T.A.M.

Anti Squat

Most cars, when accelarating hard, dip down at the back. The chassis moving down equates to the wheels moving up, hence poor traction.

With I.R.S., camber change overloads inside tyre edges, unless static camber is set positive, which then degrades cornering power. Attitude change also upsets aerodynamic rake.

Also with I.R.S., the suspension sees the driving thrust as acting at hub level, which limits the amount of anti squat to 20% or less. With live axles, the thrust acts at ground level and percentages of more than 100% are practical. Indeed, where traction is at a premium, such as trials cars or dirt track sprinter, this property makes live axles all but essential.

To find the percentage of anti-squat with live axles, refer to Fig 1/. The trailing arm lines are projected to meet at an instantanious centre IC. This point is then projected to the contact patch. Where this projection crosses the C of G line is the anti-squat-centre and it's height compared to the C of G gives the anti-squat percentage.

Fig 2/ showes parallel trailing arms heigher at the front. In this case, I.C. is at infinity and the line from infinity to the contact patch is parallel to the trailing arms. There can still be some anti-squat.

With horizontal trailing arms A.S. is zero and if the front ends are low as in many Lotus 7s, then anti squat becomes pro squat.

So far, all this is revision. Now we come to the new concept.

Bump and Roll Steer

If T.A.s are equal, parallel and horizontal, then for double wheel bump, the axle moves forward on an arc of radius equal to T.A. length. For a 33" T.A. this is .015" for a 1" travel or .060" for 2".

On droop the forward movement is the same. At first sight then, it would seem that in roll, if both ends of the axle move forward the same amount, then there would be nil roll steer.

Not so. The car rolls not about the horizontal, but about the roll axis, which is the line joining the front to rear roll centres. This invariably slopes down towards the front, especially in most live axle systems, so for nil roll steer, the T.A. line needs to slope down at the same angle which gives pro squat as per Lotus 7.

This can be overcome by tapering both T.A.s together an equal amount, which still gives nil roll steer but any desired amount of anti-squat.

The issue gets slightly confused by down-force, which often pushes the back down $\frac{1}{2}$". To allow for this, equal taper about the horizontal on start line should not be far out. Perhaps a little lower at the front of the top T.A.

As soon as the T.A.s become out of parallel, a geometric quarrel is theoretically introduced. Do not worry too much. At worst the axle works as a free roll bar. With the springs removed, and roll bar disconnected, jack one side up to full bump. If the system does not suddenly go stiff then any quarrel can be ignored. In practice, we have used 2$\frac{1}{2}$" of taper. It could well be safe to use much more.

Now we have minium roll steer and good anti squat, but the best is yet to come.

Anti Squat Variation

Unless A.S. is 100%, then some squat must occur. As soon as this happens then the amount of A.S. reduces and a positive feed back situation occures. More squat, less A.S. causing still more squat and less A.S. and so on. This is probably most easily understood by looking at the parallel T.A. arangement (Fig 2) but equally applies with tapered T.A.s.

This situation is bad for start line traction, but for cornering, it is much worse.

The front end of the T.A.s on the inside of corners go up with roll. On the outside they go down. This gives increased A.S. on the inside and reduced on the outside, which itself tends to increase roll and hence reduce rear weight transfer. This is possibly the reason why live axle cars always seem to roll more and give more understeer than roll stiffness calculations suggest.

What is even worse is that this Anti squat induced weight transfer depends directly on the amount of thrust, so that every time the trottle is moved, weight transfer takes place, leading to the dreaded 'Threepenny bit effect' i.e. through corner dynamic instability.

The Solution

Take another look at Fig 1/ This projection bears a close resemblance to the front view of a wishbone I.F.S. system, where the T.A.s equate to the wishbones, the I.C. to the swing axle centre and the A.S. centre to the roll centre.

Notice that with equal T.A.s the A.S. centre moves violently up and down with wheel travel, just as the roll centre would move with equal length wishbones.

The solution is the same. As the top T.A./wishbone is shortned, the computer shows that the A.S.C. / R.C. movement is reduced and at a certain point becomes zero, while further shortening causes movement in the opposite direction.

On the Mk 27SG we have shortened the top T.A. by 8" which gives nil movement of the A.S. centre.

The advantages are startling :

1/ No change of A.S. with squat and hence better and more consistant start line traction.

2/ For the same reason, improved slow corner exit traction.

3/ Improved dynamic corner stability with reduced sensitivity to throttle setting. Brake, turn, through and out. No 'Threepenny bit'.

4/ Reduced understeer due to greater but consistant rear weight transfer. Put this another way, you need less rear roll bar to prevent understeer.

5/ For the same balance you actually get less roll.

6/ The less roll bar explained in 4/ results in better road holding due to reduced single wheel suspension rate.

7/ Rear anti squat also gives braking anti lift and still less attitude change.

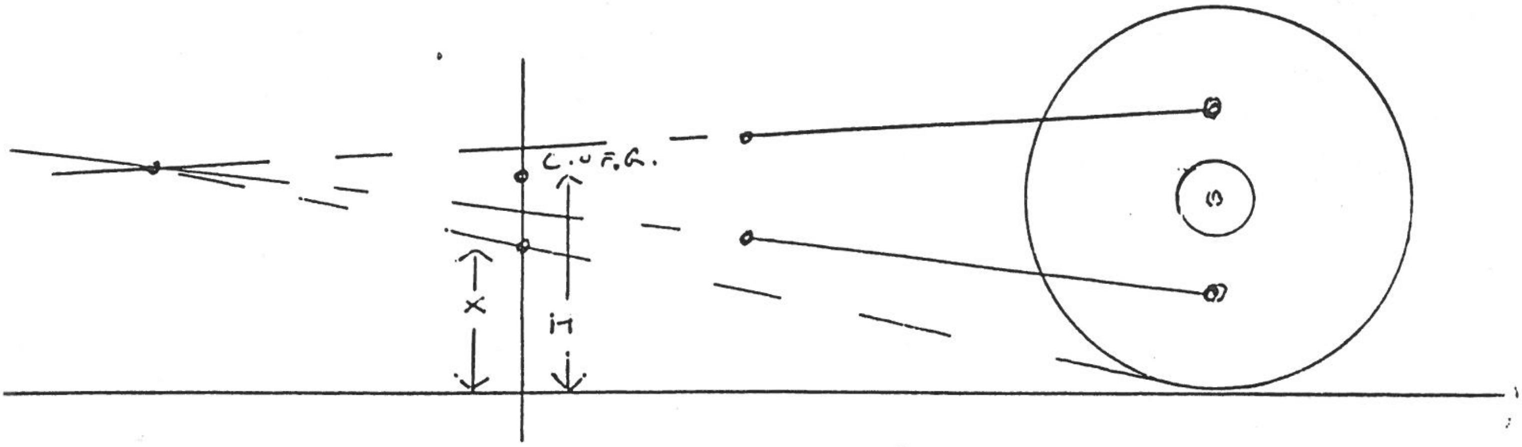
8/ Improved attitude change on both drive and braking is good in itself, especially with the Mk 27SG ground effect development, on some applications, it could be traded for softer suspension.

Future Outlook

As with the Mumford axle locating system, the short top T.A. arangement opens up a whole new field for development. Let's call it T.A.M. TRAILING ARM MAGIC.

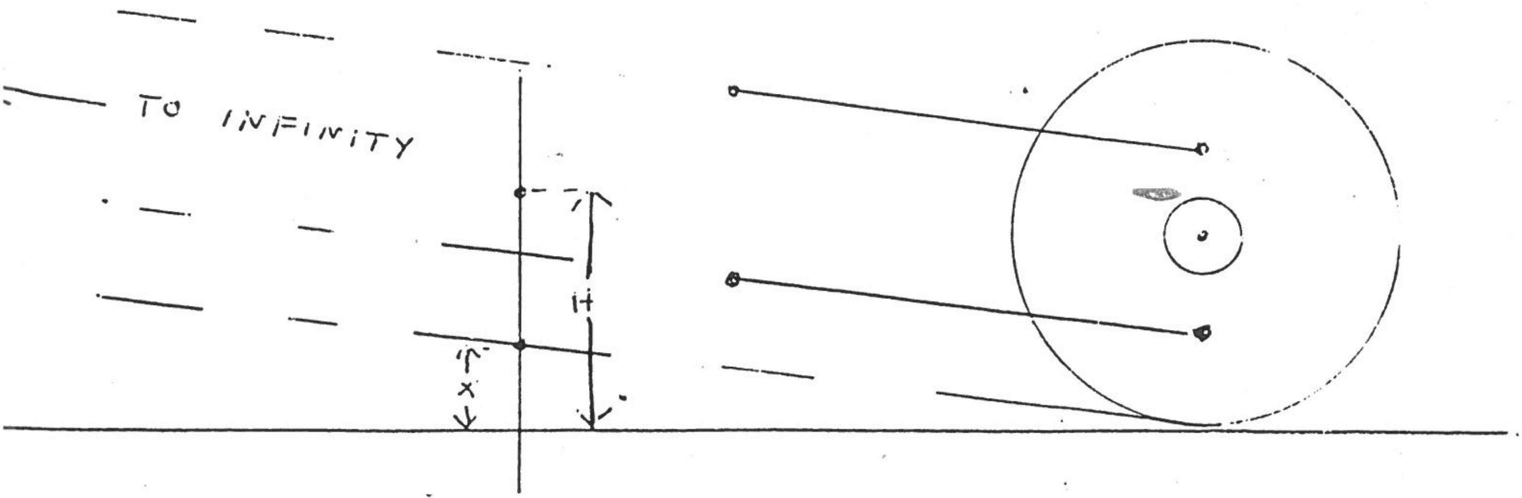
B234N1987 with U.2. TAM (Work it out!)

FIG 1



$100\frac{X}{H}$ = PERCENT ANTI SQUAT.

FIG 2.



$100\frac{X}{H}$ = % ANTI SQUAT BUT X VARIES WILDLY WITH RIDE HEIGHT.