The Mark Ortiz Automotive

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WELCOME

Mark Ortiz Automotive is a chassis consulting service primarily serving oval track and road racers. This newsletter is a free service intended to benefit racers and enthusiasts by offering useful insights into chassis engineering and answers to questions. Readers may mail questions to: 155 Wankel Dr., Kannapolis, NC 28083-8200; submit questions by phone at 704-933-8876; or submit questions by e-mail to: markortizauto@windstream.net. Readers are invited to subscribe to this newsletter by e-mail. Just e-mail me and request to be added to the list.

OLD-SCHOOL ROCKER SUSPENSION

What is your opinion of rocker arm front suspension where the top A frame continues inboard beyond the pivot point and has the shock vertical at the inner end. Space permitting, it seems a simple and effective system that minimizes joints, levers and rods and while possibly achieving nearly 1/1 shock to wheel ratio.

In its traditional form, the layout does eliminate some parts and some wear points compared to pushrod or pullrod layouts. However, it requires a long piece loaded in bending, and doesn't lend itself to rising rate as readily as pushrods or pullrods. Also, in most of the cars using it back in the day, the coilovers and the box structures containing them were about at the driver's ankles and would trap feet and crush legs in crashes. Early designs, e.g. Lotus 25, weren't so bad in this regard, and rules enacted since then requiring feet to be further aft might address this.

Coilover accessibility and shock cooling were often not very good in these designs.

In most cases, getting a 1:1 motion ratio involves making the upper arms shorter than is really desirable from a geometry standpoint, although this will depend on the particular design.

It is possible to improve the structural efficiency of the control arm/rocker by making it a truss rather than a beam, usually with the truss structure below the pivot axis. In an open-wheel car, the car would then have similar appearance and aerodynamics to a pullrod car.

Or, if we want rising rate geometry, and if the upper arms are inclined considerably to get camber recovery in roll, and if we have room above the pivot axis, we will have a markedly V-shaped rocker in front view. We may then be able to add a compression member across the top of the V, from the upper ball joint to the upper coilover end, and have a truss structure that way.

It would even be possible to incorporate adjustability into such a design, rivaling that available from a conventional pushrod and rocker. The compression member would effectively be a pushrod, of adjustable length, and the system could then perhaps be considered a pushrod system, but with the pushrod and rocker more or less integral with the control arm rather than separate.

This might offer reduction in the number of wear points and load points compared to conventional rockers, and maybe a small weight reduction. The reduced number of load points on the frame would be particularly attractive for tube frame designs.

Whether the whole concept would be advantageous would depend on how it integrates with the overall design of the car.

DE DION TUBE DESIGN AND LOCATION

I am trying to decide on the arrangement to locate a DeDion axle in an autocross car that has a transverse engine/transmission directly in front of the axle. I plan to use a watts link for lateral location. Single trailing arms on each side with a third central link does not seem appropriate because the transverse engine would dictate a very short center link.

I am considering parallel trailing arms on each side. However, I have seen applications that converge the arms on each side to a single front mount. It seems to me that in this situation there might be bending forces applied to the arms when one wheel rises and/or the other falls. Perhaps these are not significant because the axle will have quite limited vertical movement.

Which do you consider more appropriate, parallel arms or triangular arms converging to one front mount on each side?

The simple answer is to go with parallel arms. Converging arms or hairpin-style ones with a single pivot will bind in roll, unless the DeDion tube has a swivel in the middle.

A swivel in the middle complicates the DeDion tube, but this was actually a feature of many designs when DeDion suspension was popular in F1 cars – for example the Mercedes W154. That car used a tube assembly that was rigid in bending and tension/compression, but not in torsion, and single trailing arms, with outboard brakes. Lateral location was provided by a roller in a slot machined into the back of the differential housing.

The Rover 2000/3500TC used a tube that both swiveled and telescoped: it was rigid only in bending. Lateral location was then provided by fixed-length halfshafts, eliminating the need for any plunge accommodation at the shafts, and the need for any additional lateral locating mechanism. Single trailing arms were used, and brakes were inboard.

Both of these designs offer somewhat more than 100% camber recovery in roll (ignoring tire deflection), and a roll center a bit higher than the halfshafts or the roller.

The Mercedes design afforded very ample anti-lift in braking, due to the combination of outboard brakes and single trailing arms. The Rover design does not have comparable anti-lift, despite similar side-view geometry, because the brakes are inboard.

Either of these designs could also use four trailing links, and they wouldn't have to be parallel. With outboard brakes, that would permit having any desired anti-lift in braking, without significant bump steer, which is not possible with parallel trailing links.

LATERAL LOCATION OF LIVE AXLE

I'm building a 67 Camaro street car in "pro-touring" style. I'm sure you are familiar with Pro-Touring in that cars of this build style are expected to perform well in all aspects, from straight line acceleration to handling to braking. Anyway there are several manufacturers producing 4 link or similar solid axle rear suspension kits to replace the original leaf spring rear suspension. The more basic kits usually have a Panhard bar locating the axle laterally. However, some of the more expensive kits use a Watt's link to get rid of the lateral motion of the rear axle through suspension travel that is inherent to the panhard bar design. However, I have seen a few suspensions that use a diagonal bar that connects between the front left to rear right joint (or vice-versa) of the lower links providing triangulation to locate the rear axle laterally. Since the diagonal link moves in the same plane as the other two lower links in basic bump it appears to achieve the same effect as the Watt's linkage but with a much simpler solution. I'm not sure about roll though. Does the diagonal bar in fact achieve the same effect as a Watt's linkage? Can you give a basic comparison of the three systems and when they should or should not be used?

In terms of geometry, the diagonal Panhard bar does give roughly similar results to the more complex Watt linkage. It does have the disadvantage of inducing loads in the trailing links with lateral force, which the Watt linkage does not do. The load paths in a car originally designed to just have leaf springs can be quite good; the diagonal bar can attach near one of the front spring mounts.

One problem can be keeping the diagonal bar from hitting the driveshaft in certain conditions. Also, if the problem that prompts the modification is lateral compliance of the springs and shackles, the bar induces loads that will laterally deflect those parts somewhat, if the bar is simply added to the factory leaf spring suspension.

The diagonal bar has for some time been popular for drag racing rear ends with wide slicks, tubs, and relatively closely-spaced trailing links. In these installations the diagonal bar is closer to longitudinal than to lateral, and the loads on it in hard cornering can get pretty large, as can the induced loads in the other links.

The Watt linkage, when added to a layout originally designed for leaf springs, tends to require additions to the sprung structure, to pick up the loads from the lateral links. Ideally, we would really like the linkage to tie into the existing unibody rails, without the need to add a bunch of tubes to the sprung structure.

One thing that complicates matters here is that usually the unibody rails are higher behind the axle than ahead of it. What we'd really like is a lateral linkage that accommodates this.

It is possible to do this with a Watt linkage, with a bit of imagination. It is possible to have the rocker of the Watt linkage close to horizontal in side view, but a bit higher at the rear than at the front, under one of the axle tubes, anchored to the axle housing to one side of the diff, with one lateral link ahead of the axle, and one behind. The lateral links are then of unequal length. The short one goes to the unibody rail on the side nearest the rocker, avoiding any interference with the driveshaft, and feeds its loads into the rail near the front leaf spring attachment point. The other lateral link passes behind the diff, at a bit greater height from the ground, and feeds its loads into the rail where it curves down behind the axle.

There may be some interference between the rear lateral link and the fuel tank. The best resolution of this will depend on the specific installation. Some structure may have to be added to the rail.

To get the best approximation of straight-line motion with such an arrangement, the ears on the rocker need to be of unequal length, in inverse proportion to the link lengths: long ear or rocker half with short link. This is not absolutely essential, however, if packaging considerations dictate a deviation from this relationship. It is not absolutely essential to have true straight-line motion, just something reasonably close, with good load paths and nothing running out of travel or hitting anything else.