

## **Table of Handling Characteristic Causes and Effects**

### **SECTION ONE – EFFECT LISTED FIRST**

#### **A – INSTABILITY**

##### **EFFECT ON VEHICLE**

##### **Straight line instability – general**

###### **POSSIBLE CAUSES**

Rear wheel toe-out, either static due to incorrect setting or dynamic due to bump steer  
Vast lack of rear downforce  
Broken Chassis or suspension member or mounting point  
Wild amount of front toe-in or toe-out

##### **Straight line instability under hard acceleration**

Limited slip differential worn out or malfunctioning  
Insufficient rear wheel toe-in

##### **Straight line instability – car darts over bumps**

Too much front toe-in or toe-out  
Uneven front caster setting  
Uneven front shock forces or bump rubbers  
Front anti-roll bar miles too stiff

##### **Instability under the brakes – front end darts or wanders**

Too much front brake bias

##### **Instability under the brakes – car wants to spin**

Too much rear brake bias or too much positive camber on rear tires

#### **B – RESPONSE**

##### **Car feels generally heavy and unresponsive**

Too much aerodynamic downforce

##### **Car feels sloppy, is slow to take a set in corners, rolls a lot**

Too little shock absorber damping  
Insufficient roll resistance or ride rate

### **Car responds too quicky – has little feel – slides at slightest provocation**

- Too little downforce
- Too stiff in either ride or roll resistance
- Too much shock
- Too much tire pressure

## **C – UNDERSTEER**

### **Corner entry understeer – won't point in and gets progressively worse**

Common complaint. Can be caused by:

- Insufficient front track width
- Front roll stiffness too high
- Front roll center too low
- Insufficient front shock absorber bump resistance
- Insufficient front downforce
- Excessive dynamic positive camber on outside front tire
- Braking too hard and too late
- Too little front roll resistance – falling over on outside front due to track width ratio or diagonal load transfer. Can often be reduced by increasing front roll resistance though doing so will increase lateral load transfer.

### **Corner entry understeer – car initially points in and then washes out**

- Too much front toe-in
- Insufficient front downforce
- Insufficient front roll camber compensation
- Non linear load transfer due to roll axis inclination
- Insufficient front wheel travel in droop
- Too little front shock bump resistance

### **Corner entry understeer – car points in and then darts**

- Insufficient front wheel travel in either bump or rebound
- Too much front bump rubber
- Nose being sucked down due to ground effect

### **Corner exit understeer – slow corners**

Big trouble. Often a function of excessive corner entry and mid-phase understeer followed by throttle application with understeer steering lock which causes the driving thrust on the inside rear wheel to accentuate the understeer.

First step must be to reduce the corner entry understeer. If the condition persists, increase the rear anti-squat and reduce the front shock rebound forces. Educate the driver and improve throttle response.

## **D – OVERSTEER**

### **Corner entry oversteer**

I've heard of this one, but have not run into it – unless something was broken. Possible causes include:

- Diabolical lack of rear downforce

- Broken or non-functioning outside rear shock – or front anti-roll bar

- Severely limited rear suspension travel caused by interference

- Ridiculous rear spring or anti-roll bar

- A slight feeling of rear tippy-toe type hunting on corner entry can be due to excessive rear toe-in or to excessive rear rebound forces

### **Corner exit oversteer – gets progressively worse from the time that power is applied**

- Worn out limited slip

- Insufficient rear spring, shock, or bar allowing car to fall over on outside rear

- Too much rear roll stiffness

- Too little rear downforce

- Too little rear toe-in

### **Corner exit oversteer – sudden – car takes its set and then breaks loose**

- Insufficient rear suspension travel

- Dead rear shock

- Too much rear bump rubber

- Too much throttle applied after driver's confidence level has been increased by car taking a set

- Sudden change in outside rear tire camber

## **SECTION TWO – CAUSE LISTED FIRST**

### **A – RIDE AND ROLL RATES**

#### **CAUSE**

**Too much spring – overall**

## EFFECT ON VEHICLE

Harsh and choppy ride. Car will not put power down on corner exit, excessive wheelspin.  
Much unprovoked sliding.

### **Too much spring – front**

Initial understeer – although car may point into corners well. Front end breaks loose in corners. Front tires lock over bumps.

### **Too much spring – rear**

Oversteer immediately upon power application coming out of corners. Excessive wheelspin.

### **Too little spring – overall**

Car contacts race track a lot  
Floating ride with excessive vertical chassis movement  
Sloppy response  
Car is slow to take its set – may take more than one

### **Too little spring - front**

Chassis grounds under brakes  
Excessive roll on corner entry  
Initial understeer – won't point in

### **Too little spring – rear**

Excessive acceleration squat and accompanying rear negative camber  
Car fall over on outside rear tire as power is applied causing power oversteer

### **Too much anti-roll bar – overall**

Car will be very sudden in turning response and will have little feel  
Will tend to slide or skate rather than taking a set  
May dart over one wheel or diagonal bumps

### **Too much anti-roll bar – front**

Initial corner entry understeer which usually becomes progressively worse as the driver tries to tighten the corner radius

### **Too much anti-roll bar – rear**

Corner exit oversteer. Car won't put power down but goes directly to oversteer, with or without wheelspin

## **B – SHOCK ABSORBER FORCES**

### **Too much shock – overall**

Very sudden car with harsh ride, much sliding and wheel patter  
Car doesn't absorb road surface irregularities but crashes over them

### **Too much rebound adjustment**

Wheels do not return quickly to road surface after displacement. Inside wheel in a corner may be pulled off the road by the shock  
Car may be jacked down in long corners

### **Too much bump adjustment**

Initial bump reaction very harsh  
Initial chassis roll slow to develop  
Car may jack up in long corners

### **Too little shock – overall**

Car floats a lot in ride and oscillates after bumps  
Response is slow and sloppy  
Chassis roll develops very quickly and in extreme cases, the chassis may even roll back after the initial roll has taken place

### **Too little rebound adjustment**

Oscillates after bumps  
Does not put power down well

### **Too little bump adjustment**

Initial bump reaction soft  
Car dives or squats a lot  
Car rolls quickly and may tend to fall over on the outside front during corner entry and the outside rear during corner exit

### **Dead shock on one corner**

Surprisingly difficult for the driver to identify and/or to isolate. At the rear will cause power oversteer in one direction only and at the front will cause initial understeer in one direction only.

## **C – WHEEL ALIGNMENT**

### **Front toe-in – too much**

Car darts over bumps, under the brakes and during corner entry

Car won't point into corners, or, if extreme, may point in very quickly and then wash out

### **Front toe-out – too much**

Car wanders under the brakes and may be somewhat unstable in a straight line, especially in response to one wheel or diagonal bumps and wind gusts

May point into corners and then refuse to take a set

### **Rear toe-in – too much**

Rear feels light and unstable on corner entry

### **Rear toe-in – too little**

Power on oversteer – during corner exit

### **Rear toe-out – any**

Power oversteer during corner exit or in a straight line

Straight line instability

### **Front wheel caster – too much**

Excessive physical steering effort accompanied by too much self return action and transmittal of road shocks to driver's hands

### **Front wheel caster – too little**

Car too sensitive to steering

Too little steering feel, self return, and feedback

### **Front wheel caster – uneven**

Steering effort harder in one direction than in the other

Car swerves in one direction (toward the side with the high caster setting) in a straight line

### **Negative camber – too much**

Inside of tire excessively hot or wearing too rapidly. At the front, this will show up as reduced braking capability and at the rear as reduced acceleration capability. Depending on the race track and the geographic location of the tire measuring point inside, the tire temperature should be 10°F to 25°F hotter than the outside

### **Positive camber – too much**

Outside of tire will be hot and wearing. This should never be and is almost always caused at the rear by running too much static camber in the effort to prevent excessive negative camber under the influence of the wing at high speed. Will cause corner exit oversteer and reduced tractive capacity. If extreme, may cause corner entrance instability.

At the front it is usually caused by excessive chassis roll or by insufficient roll camber compensation in the suspension linkage and will cause understeer after the car has pointed into the corner

### **Bump steer, front – too much toe-in in bump**

Car darts over bumps and understeers on corner entry

### **Bump steer, front – too much toe-out in bump**

Wanders under the brakes and may dart over one wheel bumps or in respond to wind gusts. Understeer after initial point in on corner entry

### **Bump steer, rear – too much toe-in in bump**

Roll understeer on corner entry  
Tippy-toe rear wheel instability on corner entry  
Darting on application of power on corner exit

### **Bump steer, rear – too much toe-out in bump – any**

Same as static toe-out but lesser effect – oversteer on power application

## **D – SUSPENSION GEOMETRY**

### **Rear roll center too low – or front too high**

Roll axis too far out of parallel with mass centroid axis leading to non-linear generation of chassis roll and lateral load transfer. In this case, the tendency will be toward too much load transfer at the rear which will cause oversteer

### **Front roll center too low – or rear too high**

Same as above, but in opposite direction, tending toward corner entry understeer and three-wheeled motoring on corner exit

### **Front track width too narrow in relation to rear**

Car tends to drop over its front feet during slow and medium speed corner entry evidenced by lots of understeer. Quite common in present generation of English kit cars. Crutch is to increase front ride and roll resistance and to raise front roll center. Fix would be to increase front track width.

## **E – TIRES**

### **Too much tire pressure**

Harsh ride – excessive wheel patter, sliding, and wheelspin. High temperature reading at center of tire.

### **Too little tire pressure**

Soft and mushy response, high tire temperatures, with a dip at the center of tread. Reduced footprint area and traction.

### **Front tires “going off”**

Gradually increased understeer. During the race, the only thing that the driver can do about this is to change his lines and driving technique to nurse the front tires. If we know that it is liable to happen during the course of a race, we can set the car up closer to oversteer balance than would be optimum to compensate for it.

### **Rear tires “going off”**

Same as above but in the oversteer direction. Driver adjustable anti-roll bars come in handy here.

### **Inside rear tire larger in diameter than outside (reverse stagger)**

Reduces corner entry understeer by dragging inside rear. Increases corner exit oversteer.

## **F – OTHER FACTORS**

### **Limited slip differential wearing out**

In the initial phases of wearing out, the symptoms are decreased power on understeer or gradually increasing power on oversteer and inside wheelspin. The car may actually be easier and quite pleasant to drive – but it will be SLOW. When the wear becomes extreme, stability under hard acceleration will diminish and become negative and things will not be pleasant at all.