CHASSIS DYNAMICS

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A. DRIVER / CREW CHIEF COMMUNICATION

In order for any race car to go fast it must get around the turns quickly and comfortably for the driver. The key to building corner speed week in and week out is a strong communication relationship between the driver and crew chief. The ability of the driver to provide informative feedback to the crew chief is paramount.

I. CREW CHIEF COMMUNICATION RESPONSIBILITIES

1. Make it easy for the driver to provide clear and informative feedback.
2. Accept driver feedback "as is" and strive to understand the communication. Remember, if the driver is not satisfied with the cornering of the car then some corrective action must be taken to make him more comfortable.
3. Build the driver's confidence by accepting his feedback when the car is not comfortable for his driving style.
4. The driver may have trouble expressing what the car is doing. Strive to understand the true problem. If a driver is unhappy with the car something needs to be fixed. The problem may be different from his feedback but there is a problem that still needs to be identified. If the driver is not comfortable with the car you must find a way to make it more comfortable.

5. Ask the driver many questions relating to his feedback. Cut through any emotion and provoke quality responses. Keep the egos out and listen intently.
6. Offer suggestions about different potential chassis changes that address the driver's concern.
7. Realize that all drivers use their own style and that a previously successful set up from another driver may not work for someone utilizing a different style. Adapt to the current driver instead of forcing him into a mold.
8. Break the corner down to invoke clear feedback.

II. Driver Communication Responsibilities

1. Feel the car and communicate the characteristics of the car in order. Express feelings about each section of the corner without too much emotion.
2. Express what the car is doing to the crew chief before suggesting any chassis changes. Proper corner feedback provides for a lot of information to assess. Making adjustment suggestions at the same time interferes with the driver's ability to clearly express the feeling from the car to the crew chief.
3. Remember to provide feedback in digestible amounts. Allow the crew chief to analyze the information before suggesting changes.
4. After the crew chief has analyzed driver feedback, tire temperatures, air pressure and stagger information it is then appropriate to discuss possible changes with the crew chief.
5. Give your crew chief the benefit of the doubt on the close calls. Avoid running around the pits getting random advice.
6. Take <u>your</u> best information and make a decision.

B. Breaking Down the Corner

To achieve clear and concise information it will help the driver and crew chief if they look at the corner in sections. By using common terminology, the driver and crew chief will better understand the specific area in the corner that needs addressing.

I. Corner Entry

The corner entry is the area where the driver lifts and begins braking. Maximum braking pressures usually occur at the end of this area. Steering input is just beginning.

II. The Cut Zone

The cut zone is the area just past the corner entry where the car begins to turn or cut down into the corner. Brakes are usually applied strongly but brake pressures are decreasing as the car passes through the cut zone. Steering input is increasing as the car travels down into the corner.

III. The Middle

The middle is the area just past the cut zone that contains the actual apex of the turn. The apex is the true center of the corner where the car changes direction. At some tracks this can be before the visual center of the turn. Braking pressures are ideally at zero before entering this zone and the car is allowed to roll through the middle. Steering input is usually at its maximum point at the apex. The car takes a set and changes direction at the apex. Acceleration begins after the car takes a set.

IV. Acceleration Zone

The acceleration zone is the area just past the middle of the turn where the driver gets down harder on the accelerator. A good roll through the middle and a strong ability to get the throttle down, sets the car up for a good turn exit. Steering input reduces as the car travels through this zone.

V. THE EXIT

The exit of the turn is the area just past the acceleration zone where the car makes the final approach to the straightaway. Steering input is reduced to zero and throttle pressure is increased to maximum as the car travels off the turn.

By breaking the corner down into sections the driver and crew chief will increase their odds of being on the same page.

C. MAKING THE MOST OF THE CORNER BREAKDOWN FEEDBACK

In order to communicate properly each section of the corner should be discussed in order. There is no benefit in worrying about the center of the corner if the car is unstable on entry. The preceding zone affects the next zone. Make sure that the car makes a good entry, then cuts, then rolls through the middle, then accelerates and then makes a good exit. Reconsider your adjustments if your corrective action adversely affects any preceding zone in the corner area you are addressing.

Again, whenever making any adjustment you must consider each corner area. Adjustments cannot upset the preceding section of the corner.

For example, let's say that your car is stable on turn entry and pushing in the middle. You decide to put a softer RF spring in the car. After installing the RF spring the car becomes unstable on entry. You now must make an adjustment to make the car stable on entry, as a car that cannot get into the corner comfortably will lose speed throughout the rest of the turn. Cure the entry before worrying too much about the middle and start over if any adjustment affects a preceding area of the corner.

D. COMMON FEEDBACK TRAPS

Cars that are loose on entry nearly always push in the middle as the driver simply is unable to aggressively turn the steering wheel at the right time. Basically, a loose entry causes the

driver to miss the entire turn. There is no point making changes that deal with the middle when the car is loose in.

Cars that push in the middle of the turn are very likely to be loose on corner exit. The angular momentum of the car is upset and the car travels off the exit on the wrong line due to the push in the middle. The car pushes and moves up. On exit the car runs out of room in the groove and often becomes loose on the late exit as the driver overturns to avoid contact with the wall. Many times when you loosen the car up to get a better run through the middle it will hook up better on exit.

A car that is loose on corner entry should be cured at all costs. A car that is loose on entry is uncomfortable for the driver and is very difficult to drive. The driver really has no way to adapt his line for a loose entry problem. Basically, the driver just has to slow down and ride. Cars that are loose on entry make for a long day.

If the car is tight in the middle the driver can adjust his line and improve his situation by diamonding the track. If the car is loose in the middle or on the exit he can try a higher line. Loose entry is just a bad deal. Never allow your car to suffer through a race with a loose entry condition.

E. Adjustment Tips

Below are some tips on how you can make changes to your car. Like all general statements real world track conditions can contradict what is listed below. Proper context must prevail. The information might allow you to speed up your own learning curve through your actual track testing and race experience. Further, these tips better apply to asphalt stock cars that are built by a major manufacturer that run on tracks 1 mile and under.

All information assumes that the car has the proper parts installed and that the rear end is square. The simplest way to go fast is to insure that all four wheels are pointing in the same direction. Suggestions are listed in order of priority. Keep in mind that the order can vary drastically depending on the many variables faced and differing track conditions.

Scenario 1

Loose Everywhere

Tip: Fix it!!! Never start a race with this condition! A loose everywhere car will be very hard to drive. Driver adjustments will be of very little help. There is little benefit from small changes with this condition. Stay with changes that make a significant difference.

1. More front spring rate
2. Less rear spring rate
3. More sway bar or sway bar load
4. Lower the panhard bar
5. Less stagger

Scenario 2

Tight Everywhere

Tip: Fix it. A tight everywhere car will not be hard to drive but will be slow. There is little benefit from small changes with this condition. Stay with changes that make a significant difference.

1. Less front spring rate
2. More rear spring rate
3. Less sway bar or sway bar load
4. Raise the panhard bar
5. More stagger

Scenario 3

Loose Entry or Loose Cut Zone

Tip: Fix it!!! Never start a race with this condition!

As stated before, loose entry is one of the worst kinds of cornering problems. Curing loose entry conditions is a high priority item. Here are some things to try.

1. More front spring rate
2. Less rear spring rate
3. Less rear weight
4. More sway bar or sway bar load
5. Less rear brake bias
6. Lower the panhard bar
7. Less stagger
8. More front shock compression
9. Less rear shock compression
10. Less top link angle (less anti squat)
11. More diagonal weight
12. Less RR trailing arm angle
13. Shorter RF A-arm
14. More toe out
15. More positive caster
16. Add anti dive

Scenario 4

Stable Entry / Tight Cut Zone

Tip: Work on it. Sometimes gets worse and progresses to a push in the middle but driver can usually make some driving adjustments.

1. Less RF spring
2. More LF spring
3. Raise panhard bar
4. More rear spring rate or RR spring

5. Less diagonal weight
6. More stagger
7. More front camber if temperatures verify
8. Longer RF A-arm (maybe add static camber at same time)
9. More rear weight
10. More caster split
11. More rear brake
12. Less RF shock compression
13. More LR shock rebound

Scenario 5

Stable Entry / Good Cut Zone / Tight Middle

Tip: Fix it. Depending on severity can get worse. Driver can make limited driving adjustments.

1. More rear stagger
2. Raise panhard bar
3. Less RF spring
4. More LF spring
5. More RR trailing arm angle
6. Less diagonal
7. More LR shock rebound
8. Less RF shock compression
9. More Ackerman
10. More RR spring
11. More front camber if verified by tire temperatures
12. More caster split

Scenario 6

Stable Entry / Good Cut Zone / Loose Middle

Tip: Work on it. At some tracks this condition can come to you on a long run. However, only experience can tell you if this would be a safe gamble.

1. Less rear stagger
2. Lower panhard bar
3. Less RR trailing arm angle
4. More RF spring
5. Less RR spring
6. Less LR rebound
7. More RF compression

Scenario 7

Stable Entry / Good Cut Zone / Good Middle / Tight Acceleration Zone

Tip: Work on it. Usually gets worse. Driver can make limited adjustments. This situation works well with inexperienced drivers.

1. Less top link angle
2. Slightly more stagger
3. Small raising of panhard bar
4. Slightly more RR trailing arm angle
5. Slightly less diagonal
6. More LF shock rebound
7. More RF shock rebound
8. More RR shock compression
9. Less RF shock compression
10. Slightly less RF spring
11. Slightly more RR spring

Scenario 8

Stable Entry / Good Cut Zone / Good Middle / Loose Acceleration Zone

Tip: Fix it. Hard to drive and usually gets worse. Not recommended for the inexperienced driver.

1. More top link angle
2. Less stagger
3. Lower the panhard bar
4. Less RR trailing angle
5. More LR spring. RR spring softer than LR spring 10% +/-.
6. More diagonal
7. Less LF shock rebound
8. Less RF shock rebound
9. Less RR shock compression
10. Less Ackerman
11. More RF spring
12. Bigger sway bar or more sway bar load

Scenario 9

Stable Entry / Good Cut Zone / Good Middle / Good Acceleration Zone / Tight Exit

Tip: Work on it. Many times an excellent place to start a long race. Experience dictates if this is a good gamble. Easy to drive. Usually frees up as the tires wear.

1. Slightly less top link angle
2. Slightly more stagger
3. Small raising of panhard bar
4. Slightly more RR trailing arm angle
5. Slightly less diagonal
6. More LF shock rebound
7. More RF shock rebound
8. More RR shock compression
9. Less RF shock compression

10. Slightly more RR spring (Reduce spring split in rear to 5% stiffer LR or to equal rears)
11. More Ackerman
12. Slightly less RF spring

Scenario 10

Stable Entry / Good Cut Zone / Good Middle / Good Acceleration Zone / Loose Exit

Tip: Fix it. Hard to drive and usually gets worse. Not a good set up for the inexperienced driver.

1. More top link angle
2. Less stagger
3. Lower the panhard bar
4. Less RR trailing angle
5. More LR spring. RR spring softer than LR spring 10% +/-.
6. More diagonal
7. Less LF shock rebound
8. Less RF shock rebound
9. Less RR shock compression
10. Less Ackerman
11. More RF spring (If LF is stiffer than RF think about equal fronts or softer LF)
12. Bigger sway bar or more sway bar load

Scenario 11

Stable Entry / Good Cut Zone / Good Middle / Good Acceleration Zone / Good Exit

Tip: Run it! Take care of your equipment. Win!! Document for future use.

F. CONTRADICTIONS

Be aware that sometimes cars don't seem to follow the rules. You can get conditions that contradict the rules. Generally, you see this condition when you have gone to extremes with adjustments. "The Rules" only apply when you are near the center of the range. If you get outside the range with your adjustments many things can happen to confuse the issue.

When your car does not seem to get around the turns right you should first have a look at any adjustments that are to an extreme compared to what your car builder recommends or from what you have learned from your own experiences.

I. THE SOFT PUSH

The soft push occurs when you get below the spring rate that holds the front end up. The suspension runs through its full travel too quickly and in effect bottoms out as the car enters the turn.

"The Rules" say that you should put in softer front springs when the car pushes. What if you are already too soft? For example, lets say you typically would run 400's in the front of a coil over car or 900's in the front of a big spring car. The car has been pushing so you keep dropping front spring rate. Now, as an exaggeration, you are down to 250's in the front of the coil over car and 400's in the front of the big spring car. The car will roll through the suspension travel too quickly and the car will push even worse.

The point is that you can be fooled into going softer on the front spring rate to cure a push when the reality is that the front springs are fine but another adjustment would be a better option. When you get too soft in the front the car can push and installing a stiffer front spring actually makes the car turn better.

II. SOFT LOOSE

Just as with the soft push the same condition can occur with the rear springs. If you get the rear too soft the car can get loose as the suspension travel is used up too quickly and effectively bottoms out. In this case, a stiffer rear spring can hook the car up better.

III. SKATE

Sometimes your car will skate in the turns. The whole car seems to slide up into the second groove. The driver has trouble running the low line. Many times the driver explains this condition as a push.

1. Panhard Bar Too High

   A panhard bar that is too high can cause the skating condition. As the car gets to the "cut zone" the high panhard bar can pull the rear of the car up the track into the second groove. When this condition occurs the driver often steers to the right to catch the car as it enters the turn. By the time the car gets to the middle it is out of position and the angle of the car is pointing towards the wall instead of down the straightaway. At this point, the driver feels the car push and reports that information to the crew chief. Be aware. In this contradiction, lowering the panhard bar can make the car turn better.

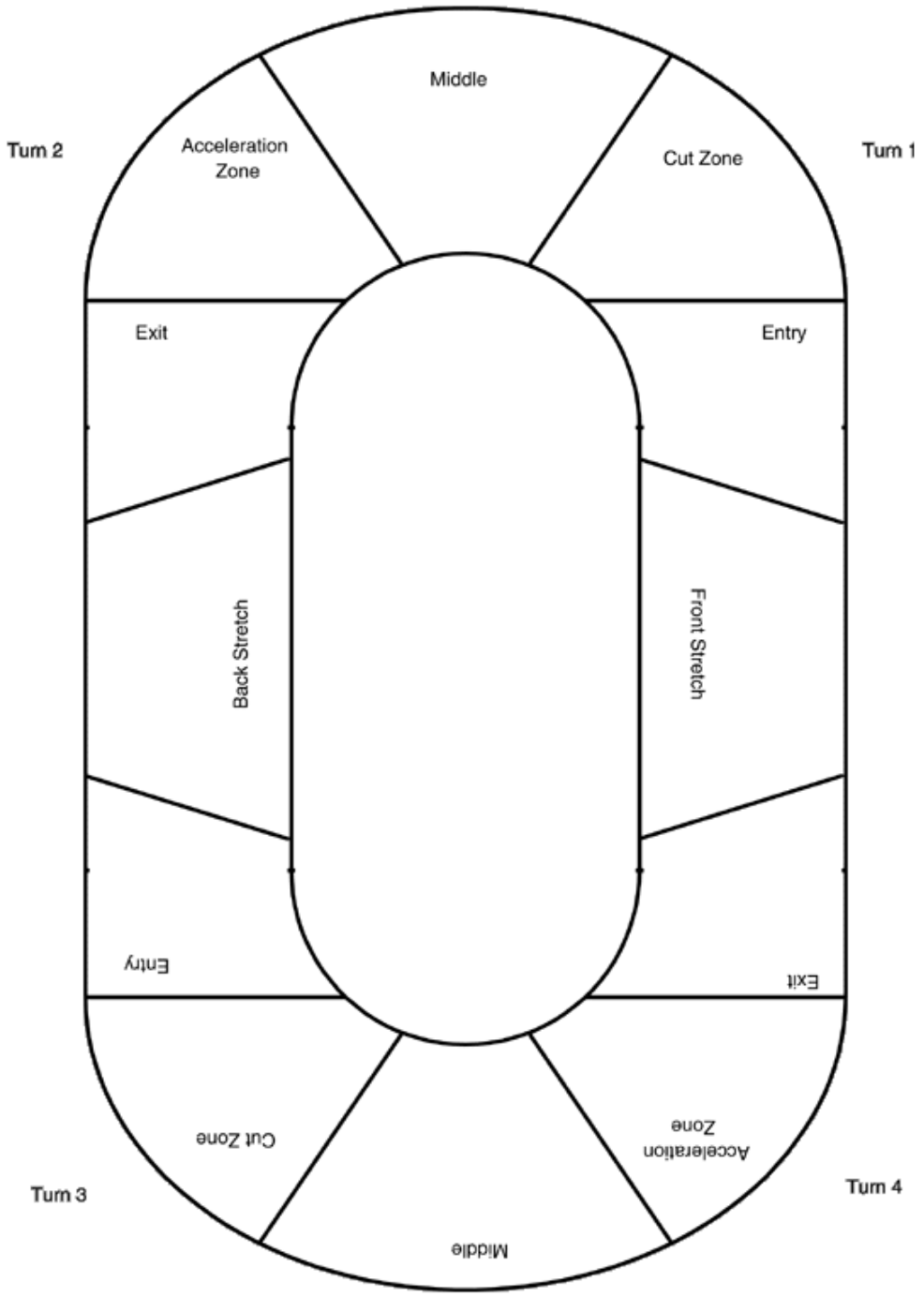
2. Too Much Rear Weight

   Too much rear weight can make the car skate very similar to when the "too high" panhard skate occurs. The pendulum effect of the rear weight pulls the rear of the car up and the driver corrects to the right. A push then occurs at the middle which the driver feels more than the entry problem. The driver then reports a push to the crew chief. In this case, less rear weight would reduce the skating problem.

Awareness of "the soft push" and "soft loose" will allow you to think of other adjustments when "the rules" are not working out.

Break the corner down, section-by-section, and you will speed both your car and your learning curve.

G. DIAGRAM


Middle
Turn 2
Acceleration Zone
Cut Zone
Turn 1
Exit
Entry
Back Stretch
Front Stretch
Entry
Exit
Cut Zone
Acceleration Zone
Turn 3
Turn 4
Middle

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