

GTS Winter Update II – Tweaking your car

By Scott Good

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Hello again,

In my last Winter letter, I talked about driving more smoothly and how you could practice on the street this winter to improve your driving on the track next racing season. Today I want to spend a few minutes talking about some things you can do at the track next year to make your car handle better.

Your car as a Swiss Army knife...

What we sometimes forget about our race cars is that they are really just big adjustable tools. That's in contrast to street cars which are, with few exceptions, relatively un-adjustable. Granted, a few of us have tweaked the suspensions of our street car with a set of coil-overs, or maybe an adjustable sway bar, but for the most part the cars we drive day in and day out are set-and-forget technology. But that's not the case with racing cars which are intentionally built for easy fiddling and pretty much constant tweaking.

So the question is, are you taking advantage of this adjustability or are you just driving what you brought to the track--either out of disinterest in, or lack of understanding of, the kinds of changes you might be making?

If you watch the faster drivers in most groups, you'll find that, for the most part, they regularly make little (and sometimes not so little) tweaks between sessions, constantly looking for a way to go just a bit faster. If you're not doing that too, chances are you're losing ground to them throughout the day and/or weekend.

And, let's face it, there's not much point in having all that adjustability if you don't use it for something. The trick, of course, is in knowing what to adjust, in which direction, and by how much. And, if this is something relatively new to you I can appreciate that the idea of just changing things for the sake of changing them can be worrying on several levels, not the least of which is the possibility you'll make a change you don't like and then not be able to get back to where you were.

That would totally suck, of course, but it doesn't have to happen. Ever.

One of the great things about the changes you can make on a car is that pretty much all of them are measurable. Shock absorbers have clicks to count. Tires have pressures and temperatures to measure. Sway bars have holes or inches of movement you can document. And springs, of course, have spring rates. The only real problem--other than actually doing the measurement and documentation--is that there are a lot of adjustable elements to deal with.

If you think about your race car, there are a lot of different kinds of adjustments you can make. On mine, for instance, I can adjust...

- Ride height at all four corners
- Shock absorber bump (compression)
- Shock absorber rebound (extension)
- Front sway bar
- Rear sway bar

- Spring rates at all four corners
- Camber, castor, toe-in at all four corners
- Front-to-rear brake bias
- Tire sizes and stagger
- Tire compounds
- Tire pressures

...and probably more that haven't occurred to me as I write this. Your adjustments are probably similar and...well...that's a lot of adjustability. Too much, maybe. For instance, my shocks have 24 positions for each bump and rebound. That means there are $24 \times 24 = 576$ possible combinations of bump and rebound PER CORNER. And, THAT means there are $576 \times 576 \times 576 \times 576 =$ over 1 billion possible shock setting combinations alone. And, that's just the shocks.

Add in all the possible settings for all the other adjustable things and pretty soon you're talking about a real number. Too many, certainly, to test in a few 20-minute sessions over the course of a weekend (or even a 100-year lifetime, for that matter). So, with an almost infinite list of possible changes, how do you ever find a good setup for your car? That's not only a good question, that's the subject of today's letter.

Finding the perfect setup

How do you find the perfect setup for your car? Or, maybe not the "perfect" setup, how about a "close-enough-to-perfect setup"? How do you find that?

First, you have to start with something. In other words, you need a starting setup. Good news! You already *have* a starting setup--whatever you're running right now. So that's your starting point. Or, it might be.

I'm hedging a bit because it would be nice to know that your starting place is relatively close to where you want to end up. That way, you'll spend a lot less time getting to a great setup. If you know you already have a pretty good setup, that's good enough for me. Use that.

On the other hand, if you're not SURE that where you are is pretty close to right, you can shortcut the system a lot by talking to other, faster, drivers with similar cars. Hopefully, either you've already done that or the shop you work with knows what kind of setup seems to work best on cars like yours. It never hurts to ask. Usually the fastest drivers are pretty close to an excellent setup so it's worth comparing the core elements with somebody you're sure knows what they're talking about--and who drives a car like yours.

Just to be clear, by "core elements," in that last paragraph, I mean spring rates, alignment settings, wheel sizes, tire compounds, ride height, and the like. And, by "somebody who knows what they're talking about" I mean somebody who is demonstrably fast, not just somebody who talks a good game. Be careful of people who act like they know what they're talking about but don't go fast...confident ignorance is no substitute for actually knowing what you're talking about when it comes to car setup.

Along those lines, keep in mind that not all shops are created equal when it comes to knowing the proper setup for a racing car. There are plenty of shops out there who know how to build motors and change gearing and do alignments and all the other mechanical things, but who don't actually, truly, know the appropriate springs and alignment and other settings for your car to make it fast on the track. And unfortunately, they'll never tell you, "We don't really know how to set your car up." That's for you to figure out.

A good indicator is that your shop is also working on front-running cars in your group. Specifically, front-running cars *like yours*. If the fast guys are going to them, that's a good thing. That's not to say there aren't other shops equally capable but if you're not sure, you at least need to weigh their advice with the suggestions you get from the faster drivers in your group (in your kind of car).

So, whether it's from what you already have, from a trusted competitor, or from a knowledgeable shop, one way or another you need to get yourself a starting point and then start tweaking. That's the name of the game--tweaking--but it helps a lot if you do it with a somewhat methodological approach. What do I mean? Well, first and foremost, measure the things you change and then *write them down*. You don't need to keep voluminous records, but you need to know what you've done both so you can repeat it if it worked and so you can back it out if it didn't. You'll start out, like I did, thinking you can keep it all in your head--and you can for a little while--but very quickly you'll lose track.

So, make a habit of keeping notes.

Also, limit your changes. A part of what you're going to be doing here is learning what differences certain changes make to the way your car handles. If you make five adjustments all at once, you'll never know which caused what change. If you go back to the idea that there are literally billions of possible combinations of suspension setup, what you want to do--at least in ideal circumstances--is to make just one change at a time so you can see what that one change did for you.

And then--again--write it down.

What to keep track of

Get a notebook you can keep in your toolbox. I've found that one with a lot of smaller pages is more valuable to me than a larger one with fewer pages, but that's for you to decide. Get a notebook of some kind.

You'll need to keep track of both (a) the things you're likely to change (like shock settings and sway bars) and (b) those that are likely to change in and of themselves (like tire pressures and ambient temperature). I start my first session of each day on a new page and enter the date, the name of the track, and a summary of all the starting settings on the car, including spring rates, sway bar positions, and shock settings.

I've worked out a form of shorthand I use to make it faster and easier to log the various bit of data for things that happen at all four corners of the car. For instance, I write down tire pressures as numbers in each quadrant of a big plus sign, like this:

```
      |
    30 | 31
-----
    31 | 32
      |
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I know when I look at this that the front left tire is 30 pounds and the right rear is 32. I do the same thing with shock absorber settings but in that case I have two values at each corner, bump (compression) and rebound (extension). In my head I always call them "bump and rebound"

since "rebound and bump" sounds wrong to me, so I write the numbers in the order I say them-- bump, slash, rebound--like this:

```
      |
    8/10 | 8/11
-----
    10/12 | 10/12
      |
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Again, the same quadrants as before. You can see here that my front right shock has 8 clicks of bump and 11 clicks of rebound. Quick and easy.

You are, of course, welcome to write your numbers however makes sense to you, but find a way to do it and always use the same method. Making it consistent means one less thing to think about and it also makes it easier to go back to later--maybe months or years later--and understand your prior notes.

So, log your starting points for the weekend.

Then, for each session, record a little weather data. It doesn't have to be fancy but it's useful to note the temperature (or a guess at the temperature) and the general weather. Is it cloudy? Raining? Hot and sunny? Whatever it is, make a quick note and do it again for each track session as these things change over the course of a day or weekend and the right setup for a cold overcast day may not be the same as one that's ideal for 95 degrees with blazing sunshine and 99% humidity.

As you go through the day, and as you make changes to any of your base settings, note the change you made. Whatever it is, write it down: "+2 bump in both front shocks." "Lowered rear by two turns on both sides." Whatever changes you make, note them.

Now you're ready to hit the track...but you're not done with paperwork.

What to do when you come off the track

As soon as you come off the track, there are a few things you have to do immediately. If you are taking tire temperatures (I don't usually, but probably should), you need to do that ABSOLUTELY immediately—I'm talking before you get out of the pits--or the data are pretty much worthless. You can analyze the values later but you need to get the numbers immediately.

Also, and if you're taking tire temps you probably already know this, you need to have come into the pits straight off a full-speed hot lap to get much value out of them. Don't do a cool-down lap if you're taking tire temperatures. Don't even do a cool-down turn. Come in with the tires as hot as you can. If possible, get somebody to help you and have him or her take your tire temps in the middle of the session once you've got the tires fully heated, then go back out and finish the session if you like.

Of course, whenever you get the temps, write them down...systematically.

Slightly less critical in terms of timing are tire pressures. There are a bunch of GTS drivers who stop in the pits after each session to take tire pressures. Personally, I wait until I get back to my pit to do it (I'm usually near the track, so it's not much of a delay) but you should do it consistently across a given weekend so that all the readings are comparable. If you measure in

the pits, always measure in the pits. If you do it in your garage, always do it in your garage.

Write down your finishing pressures. I make a second "plus" next to the one for my starting temps, so I end up with something like this:

30		31		39		41 $\frac{1}{4}$

31		32		39 $\frac{1}{2}$		40 $\frac{1}{2}$

That makes it easy to see the changes.

Also, right after you write this down, I suggest you consider adjusting the tire pressures to what they *ought* to be. I don't know if you've noticed this but the starting pressure you need to use varies by corner. At Mid-Ohio, for instance, on cold tires I usually have 2-3 pounds less pressure in the front left than I do in the right rear. The numbers above are in the range of numbers I typically see.

I race on Hoosier R6s which are faster at higher pressures so I try to be at 39-40 lbs hot. As soon as I finish recording my coming-off-the-track pressures and before the tires cool anymore, I adjust the pressures to where I want them to be when they're hot. In this case, I'd probably make them all 39 (and then note that I'd done it) and NOT mess with them before the next session unless I then decide to rotate the tires or the weather changes significantly. This is a quick and easy way to get your pressures to be almost perfect starting with the second session and takes into account the necessary stagger in cold temperatures that's needed to balance them out on the track.

Okay...so you've done your pressures and temperatures immediately. That's good, but you're not done yet. Grab a drink, hop out of your driving suit if you choose to, then find a chair where you can spend a few quiet minutes.

Try to do this as soon as you can after getting out of the car.

Take a few minutes to think your way around the track. Consider each turn and break it into three sections, (1) entry (which would include braking), (2) mid-turn, and (3) exit. Try to remember how the car felt in each part of each turn and jot down whatever comes to mind about how it felt. Don't try to analyze it, just get everything down on paper. Later, these notes will help you figure out what changes to make on the car.

What do you write down? Whatever you remember. Is it squirrely under braking into a particular corner? Write that down. Is it loose when you turn-in but then pushes on the way out? Write that down (and be sure to note where). Does it bounce too much in a turn? Note it. Try to avoid statements like, "It was loose everywhere" unless you are completely sure that's true. More likely, it's loose in a lot of places but maybe not in a few others--like the slower corners, for instance, which may be different. Write down what it actually did, as specifically as possible.

I like to include my best lap times in my notes for reference, and often will also note the times of the drivers in my class running nearest me. If I'm not the fastest in the class, I always try to note who was and how fast they went as that is a useful metric with which to measure your relative performance.

This process doesn't have to take very long. Usually, it's no more than a few minutes but getting

those first impressions down on paper while they're fresh in your mind is worth a lot when it comes time to make adjustments.

How to know what to change

Once you've made your track notes, relax. Go shoot the breeze with your buddies, get lunch, or do whatever. Eventually, though, come back to the notes and figure out what needs tweaking.

Different people have different approaches but my goal is to change something every session. I don't always do it, but that's my intention. What I've found is that even when the car seems like it's perfect, sometimes I can make a change that makes it even better. So, I try to tweak a little all the time and keep good notes so I can reverse anything I don't like before the next session.

If you go back through your just-off-the-track notes and try to organize them in your head in terms of similar turns, chances are you'll see a pattern of some kind.

For instance, at Mid-Ohio, which I think most of us are familiar with (here's a map: <http://www.imsaracing.net/2007/events/Mid-Ohio/Mid%20Ohio%20Track%20Layout%20Map.pdf>), turns 1 and 14 (as numbered on the linked map) are both fast left-handers. If you are having similar problems in both turns (for instance, the car won't turn in, or it's loose on exit), that's something you can probably improve with tuning.

Similarly, the Keyhole (3 on the map) and Carousel (15) are very similar in that they are both comparatively slow right-hand double-apex turns coming off very fast straights and leading back onto major straights. If you're having a similar issue in both of these turns (can't turn in?) that can probably be tuned out, too.

When you start comparing the issues in similar turns you'll quickly find something you want to improve. Try to pick just one thing to work on at a time, but that doesn't mean you can't be THINKING about what else you may need to do for other turns and taking that into consideration for your choice of changes.

For instance, let's say you're pushing on entry to the Carousel and Keyhole and just can't get the car to turn in. What can you do about that? Actually, there are several options. Your best bet is to keep a cheat sheet nearby that helps you make these kinds of decisions. I've attached the one I use. Feel free to use it for yourself or to find another that suits you better. (If you have one you think is better than this, I'd love to get a copy of it! Send it to sgood@teamsol.com)

Looking at this chart to solve the push-on-entry problem in the Keyhole and Carousel, you can follow the decision tree...

Understeer > Corner entry > Mid-low speed > ...

...and quickly see that there are three changes you can make to address the problem: (1) increase castor, (2) increase toe-out, and/or (3) lower the front end. So, which change should you make? One consideration might be to consider which of these changes you actually know how to make. If you know how to lower the nose but not change castor or toe-out, lowering the front would be a good choice for you.

Another consideration is what other issues you may need to address later. For instance, if you are also fighting oversteer on the exit of most turns, the only option for tweaking that (at least

according to this chart) is lowering the rear end. That's great but lowering the rear end will negate any improvement you get by lowering the nose (and visa versa) so lowering the nose is probably not a great choice for addressing your slow-turn push in that case. Maybe, instead, you'll want to add a little toe-out for the slow-speed turn-in and then (later) lower the rear a bit to try to address the oversteer on exit.

It can get a little complicated but it helps if you keep in mind that these adjustments are changes to a system and not just tweaks being made in a vacuum. Every change affects something else, too, so you have to keep that in mind. In the notebook I use for my track notes, I took all of the changes shown on the chart and rearranged them into groups organized by the adjustment. For each, I've listed the full set of effects it will have. For instance...

Reduce rear ride height

Reduces oversteer at exit of turn

Reduces mid-corner oversteer on mid-low speed turns (if the rear is rolling excessively)

Reduce front ride height

Reduces corner-entry oversteer on any speed turn

Reduces mid-turn oversteer (if the front is rolling excessively)

...and so on. In combination with the flow chart, this gives me a way of seeing all the effects any one change is likely to bring because, remember, it's going to affect everything on the list, not just the one thing you care about. I find that it helps to give me a sense of what all is in play when I'm trying to decide which is the best trade-off to test out.

Once you've decided on a change, write it down AND QUANTIFY IT. Don't just write, "Lowered the front slightly," write the specifics of what you did: "Lowered the front two full turns on both sides." Without the specifics you (a) won't be able to recreate it again some day and (b) won't be able to reverse it if it doesn't work.

A note here about making changes. If you're new to this, your first inclination will be to make very small changes so you don't do anything really bad. Your better bet, however, is to make a larger change than you may think you need so that you have a better chance of actually feeling the result of that change. As you get closer to an optimal setup--and as you get better able to feel the nuances of setup--you can start making smaller adjustments. At first, though, go big. You can always back it out.

Once you've made your change (and written it down), get it back out on track and see how it feels. Try to pay attention to the thing(s) you were trying to fix and see what difference it made, if any. Of course, also pay attention to the other parts of the lap so you can figure out what to work on next and/or what you may have made worse with your last change.

When you come back off the track, start all over again with more notes, including thoughts about how the changes you made worked. If it did what you hoped it would, great! Now, do you need to do even more of the same thing--or a little less--or is there another issue you want to address? You won't get it all right at first. Rather, it's a constant tweaking process which, over time, will gradually make your car both faster and easier to drive.

A lot of work?

This may all seem like a lot of work. After all, isn't it easier to just show up at the track and drive? Well, yeah. Sure. But wouldn't you rather go a little faster? And, for that matter, what else

are you going to do? Sit around? Jawbone with the guys in the next garage? That's fine for a while but for a lot of us an important part of the fun of racing is in being our own engineers and working through issues like these. Even if that's not really your bag, keeping good notes can give you something to take to your mechanic, or the guy you're sharing the garage with, to use as a way to discuss changes that may be worth making.

Nothing I've described here is hard to do. Really, it just takes a little commitment to taking notes. And, if all you do at the start is take the notes and not make the actual adjustments, that's OK. You'll at least have something to study and use when you're ready to start tweaking. Over time, you will be surprised how big a difference a lot of little changes can make in the way your car goes and in the lap times you are able to run.

Now--to borrow a phrase from Monty Python--for something completely different...

Things to put on your Christmas (or whatever) list

If you're like me, you're always looking for a few reasonably-priced items to put on your Christmas/ Hanukah / Kwanza / Chinese New Year gift list. Below are a few books you might want to consider adding...



Driving in Competition

by Alan Johnson

I have a soft spot in my heart for this book as it was the first one I ever read on the subject of road racing technique. Running through the head of a 15-year-old, this was dangerous stuff.

I recently bought myself a new copy and found it, on the one hand, slightly naive and simplistic but, on the other, also incredibly on the mark. There's a lot of advice in here that you probably don't need about how to get started with racing and such but it is completely worth the price if for nothing more than Alan Johnson's detailed but understandable explanations of how to analyze a race track to figure out what matters most in terms of lap times. He makes it simple and understandable.

This is not a coffee table book. It looks like it was last printed in the 70s and the typesetting and images are amateurish by today's standards. In spite of that, I find myself re-reading the parts about the various types of corners once or twice a year just to make sure I have it completely right in my head. Highly recommended.

You can get it here:

<http://www.amazon.com/gp/product/0393600114?ie=UTF8&tag=qoodthin-20&linkCode=as2&camp=1789&creative=9325&creativeASIN=0393600114>



Competition Car Aerodynamics

by Simon McBeath

If you have an interest in aerodynamics, as I do, it's hard to find something that's simple enough to actually be readable by mortals and yet which has enough information in it to give you ideas you can use on your own car. I have found two books (out of the six or more I have on the subject) which do this, and this one does it best.

The information here is well-written and pretty understandable. Having said that, it's still aerodynamics so it's not exactly John Grisham. You may find that this is a book you'll want to skip around in rather than read from front to back but the computer-generated images of pressure areas are rather amazing and quite informative once you get the hang of how to understand them.

If you're interested even marginally in aero, this book is highly recommended. You can get it here:

<http://www.amazon.com/gp/product/1844252302?ie=UTF8&tag=qoodthin-20&linkCode=as2&camp=1789&creative=9325&creativeASIN=1844252302>



Race Car Aerodynamics, Designing for Speed

by Joseph Katz

I found this book to be a bit more readable and bit less informative than Simon McBeath's book, above, but it's still a good aero book, particularly as a back-of-the-potty reference that you can just pick up and read for a few minutes. If I could only have one of these books I'd choose the one above but this one has some really useful and somewhat-more-understandable examples of how aerodynamics work on automobiles

You can get it here:

<http://www.amazon.com/gp/product/0837601428?ie=UTF8&tag=goodthin-20&linkCode=as2&camp=1789&creative=9325&creativeASIN=0837601428>

I hope you find at least some of this too-long e-mail helpful. Have a great Thanksgiving!

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