



THE RACE ENGINEER'S METHOD

How to diagnose a race car's behavior and turn feel into setup — a method that works for any car, in any simulator.



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PART I · FUNDAMENTALS

01

The car doesn't lie

Why car setup is diagnosis, not trial and error — and why the driver who changes six things at once never finds out which one worked.

BY THE END OF THIS MODULE YOU WILL

- Know what a setup really is — and what is just fiddling with numbers
- Master the three questions that open any diagnosis
- Apply the cycle observe → diagnose → predict → test
- Write a falsifiable prediction before every change
- Recognize when the problem isn't the car but the driving

1.1 The scene that keeps repeating

You leave the garage, run five laps, and the car is bad. The rear steps out on the exit of turn 6, the front won't turn into the chicane, and by the end of the stint the tires feel like soap. You come back to the pits, open the setup screen, and do what seems obvious: soften the rear bar, touch the differential, add wing, drop the pressures and, since you're there, change the dampers too.

Back on track. The car is better. Half a second. You celebrate — and for the next three weeks you never manage to repeat that setup, because you have no idea which of the five changes did the work. Worse: one of them probably made the car *worse*, and the gain from the other four paid for it without you noticing.

That scene is the reason this book exists. Not because you got the values wrong — the values may even have been right. You got the **method** wrong.

Car setup is not about finding good numbers. It is about turning a subjective complaint into a small number of justified changes — and knowing, before you drive, what each one should do.

1.2 What a race engineer really does

On a real team, the driver comes into the pits and talks. He doesn't talk in newtons or degrees of camber: he says the car "lets go in the middle of 7," that it "won't stop straight in the long braking zone," that it "goes away after lap eight." The engineer hears that description and does something that looks simple and in practice is hard: **he converts the language of feel into a mechanical hypothesis.**

Notice there are two distinct steps there, and most people skip the first. Step one is to *diagnose* — decide which subsystem of the car is responsible. Step two is to *prescribe* — choose which parameter of that subsystem to change, in which direction, and by how much.

When you hear "the car won't turn in" and immediately think "soften the front bar," you skipped the diagnosis. Lack of turn-in in a slow corner and lack of turn-in in a fast corner are different problems, with different causes, solved by different subsystems. The complaint is the same; the car is not.

KEY CONCEPT · THE DIFFERENCE THAT DEFINES EVERYTHING

Symptom is what the car does. **Cause** is why it does it. **Adjustment** is what you change.

Going straight from symptom to adjustment, skipping the cause, is the most expensive mistake in sim racing — and it is exactly what a "problem → fix" index encourages when used without method. This book has one of those in Module 10. It only works once you know how to diagnose.

1.3 The three questions

Every diagnosis starts with the same three questions. They look trivial and they aren't: each one points to a **different subsystem** of the car. Answer all three and the adjustment almost always becomes obvious. Skip any one and you'll spend the whole session pulling the wrong lever.

Question 1 — Where in the corner?

Entry, mid-corner, or exit. The phase of the corner determines which parameters are even active at that moment. The power side of the differential does absolutely nothing while you're braking. The anti-roll bar barely works while the car is straight. Saying "the car is loose" without saying the phase gives away a third of the information.

Question 2 — At what speed?

Slow corner or fast corner. This answer separates **mechanical** from **aerodynamic**. At low speed the car runs on springs, bars, differential, and tires. At high speed it runs on downforce, and the platform — ride height, stiffness, floor stability — takes over. A problem that only shows up at high speed is almost never fixed with a bar.

Question 3 — At what point in the stint?

Lap 1, lap 8, or lap 20. This is the question most people forget and the one that saves the most time. If the car is bad from the first lap, the problem is **balance** — the split of grip between front and rear, which Module 2 defines precisely. If it is good and gets worse with the laps, the problem is **thermal** — and no bar in the world fixes a tire outside its operating window.

COMMON MISTAKE NO. 1 · TREATING THERMAL AS BALANCE

A car that gets nervous from lap eight onward doesn't have a setup problem. It has a temperature problem. If you respond by stiffening the rear, you'll create a second problem — and now you have two, one of them invented by you.

Rule: a problem that appears with heat or with laps gets solved before any balance adjustment. A tire outside its window gives a false reading on absolutely everything.

1.4 The setup cycle

The whole method fits in five steps, and the order is not negotiable.

#	STEP	WHAT YOU DO
1	Observe	Drive the car as it is. Collect symptom, phase, speed, and point in the stint. Don't touch anything.
2	Diagnose	Say out loud, in one sentence, which subsystem is to blame and why.
3	Predict	Write down what should change in the behavior — and what proves you wrong.
4	Change	One adjustment. Two at most, and only if they are in different subsystems.
5	Check	Drive and compare with the prediction. Right: carry on. Wrong: the diagnosis was wrong, go back to step 2.

The step almost nobody does is three. And it is precisely the one that separates engineering from guessing.

1.5 The falsifiable prediction

Before you leave the pits, you need to be able to complete this sentence:

"This should do X. If Y happens instead, my diagnosis was wrong and the cause is something else."

A concrete example. Diagnosis: the rear steps out on throttle because the differential is too open and the inside wheel spins away. Prescription: increase the preload. Prediction: *"The rear should stop sliding on the exit of slow corners and traction control should cut less. If instead the car starts running wide on exit, I've gone too far and should back off. And if nothing changes, the problem was never the differential."*

Notice what that sentence does. It turns the next stint into a **test**, with an interpretable result, instead of a vague impression. It also protects you from setup's worst enemy, confirmation bias: after changing the car you *want* it to be better, and without a prediction written beforehand, you'll feel improvement where there was none.

And it has a third effect, the most valuable in the long run: when the prediction fails, you've learned something about the car. A prediction that fails is worth more than a guess that lands.

1.6 One change at a time

The simplest rule in the book and the most violated. One change per stint. Two at most, and only if they act on different subsystems — for example, one brake adjustment and one suspension adjustment, which act on separate planes and don't get mixed up in the reading.

The objection is always the same: "but that takes longer." It takes less. Three simultaneous changes that yield two tenths teach you nothing and can't be undone selectively. One isolated change that yields zero teaches you that lever wasn't the problem — and that is permanent information about the car.

COMMON MISTAKE NO. 2 · THE CURE THAT BECOMES THE DISEASE

Isolated adjustments pile up. Each one was justified at the time; added together, they create an incoherent car. The classic case: on long-straight circuits, adding wing for lack of confidence, adding toe to generate temperature, and closing the ducts to hold heat. Each decision defensible. Together, they turn a low-drag car into a medium-drag one at the track where drag costs the most.

Antidote: keep a change log with the reason for each one. Once per session, read the whole list from the top and ask whether the set still makes sense — not just each line.

1.7 Every adjustment has a price

No change is free. Every adjustment buys one behavior and sells another, and an honest engineer **names the price before charging it**. More rear toe buys stability and sells straight-line speed and tire life. More wing buys confidence in fast corners and sells top speed. A more locked differential buys traction and sells rotation in slow corners.

When you know the price in advance, you're not surprised on lap twenty — and, more important, you can decide whether the price is worth it for *that* track and *that* race. Stability that costs half a kilometer of straight is excellent at a tight circuit and terrible at one with long straights.

1.8 When it isn't the car

A good engineer knows how to say the car is fine. That is unpopular and it is necessary, because some setup symptoms are actually driving symptoms — and they disguise themselves very well.

WHAT YOU FEEL	IT MAY BE THE CAR	BUT IT MAY ALSO BE
The front won't turn in	Front balance	Entry speed too high: excess speed reads exactly like a lack of front
The rear steps out on exit	Differential, traction	Throttle opened too early or with steering still applied
Unstable under braking	Brake bias	Pedal stabbed instead of progressive; brake applied with the car already turning
Inconsistent	Setup on the edge	Braking references not yet fixed

The most honest way to separate the two cases is repeatability. A setup problem shows up *every* lap, in the *same* place, with the same intensity. A driving problem varies: it shows up on three laps out of five, and goes away when you're calm.

AT THE WHEEL · THE FIVE-LAP TEST

When in doubt between car and driver, run five laps deliberately **below your limit**: brake a little earlier, enter without hurry, progressive throttle. In racing this is called driving **"at eight-tenths"** — at about 80% of the pace you can get out of the car. If the symptom disappears completely, it's driving — you were operating beyond what the car offers at that point. If it stays the same, it's the car, and now you have a clean diagnosis, with no input noise.

1.9 This book's color code

From here on, color means something. You'll recognize the system in the tables, the diagrams, and the Cheat Sheet in Module 10 without needing a legend.



1.10 What to keep from this module

1. Setup is diagnosis before prescription. Symptom, cause, and adjustment are three distinct things.
2. Three questions open every diagnosis: **where in the corner, at what speed, at what point in the stint.**
3. The cycle is observe → diagnose → predict → change → check. The forgotten step is predict.
4. One change per stint. Two at most, in different subsystems.
5. Every adjustment has a price. Name it before you pay.
6. Sometimes the car is fine. Being able to say so is part of the job.

Exercises

Do all four in sequence, in the same session, with the same car and the same track. Don't jump ahead to Module 2 before you finish — the goal here is not to make the car fast, it's to install the method. Each exercise comes with a sample answer. The samples follow one case from start to finish, so you can see the method chained together.

EXERCISE 1 · REFERENCE STINT

Pick a car and a track you know. Run **eight laps without touching absolutely anything**. When you come back, write three sentences, one for each question: where in the corner, at what speed, at what point in the stint.

Success criterion: your three sentences name specific corners, not "the car in general."

SAMPLE ANSWER

Where: *on the exit of 4 and 9 the rear gets away when I get on the throttle; on entry to the 7-8 chicane the front doesn't respond.*

Speed: *all three are slow or medium corners. In the fast corner at the end of the straight, 12, the car is stable.*

Point in the stint: *from the first lap, with the same intensity through the eighth.*

EXERCISE 2 · THE WRITTEN PREDICTION

Pick **one** change for the symptom that bothered you most. Before leaving the pits, write on paper: the adjustment, the reason, what should improve, **what proves you wrong**, and the price you're paying.

Success criterion: the line "what proves me wrong" must describe a behavior observable on track — not "I'll feel it didn't improve."

SAMPLE ANSWER

Adjustment: *differential preload, one step up.*

Reason: *on the exit of 4 and 9 the inside wheel spins away and traction control cuts in.*

Should improve: *less sliding and less traction-control cut on the exit of both.*

What proves me wrong: *if the rear keeps getting away the same and the traction cut stays at the same frequency, the cause isn't the differential. If the car starts running wide on exit, I've gone too far.*

Price: *lazier rotation in slow corners — the chicane, which already didn't turn in well, should get a little worse.*

EXERCISE 3 · THE CHECK

Run five laps with the change. Compare with the prediction and classify it as one of three: **confirmed**, **failed**, or **no change at all**.

If it failed, the diagnosis was wrong — not the value. Go back to the three questions. If nothing changed, the lever wasn't the problem: that's permanent information, write it down.

SAMPLE ANSWER

Turn 9 — confirmed. *The rear stopped getting away and the traction cut almost disappeared.*

Turn 4 — no change at all. *The sliding is the same. Turn 4 is uphill and the problem there must have another cause: a new hypothesis, not one more step of preload.*

Price: *the chicane got lazier, as predicted.*

EXERCISE 4 · THE FIVE-LAP TEST

Run five laps deliberately **below your limit**: brake a little earlier, enter without hurry, progressive throttle. In racing this is called driving **"at eight-tenths"** — at about 80% of the pace you can get out of the car. Did the symptom go away or stay?

Success criterion: you can state, with evidence, whether the problem is the car or your driving. Record the conclusion — it changes everything you'll do in Module 4.

SAMPLE ANSWER

Chicane 7-8: *braking earlier, the front started turning in without trouble. The symptom was mine — I was arriving too fast. Not a case for an adjustment.*

Turn 4: *even with smooth throttle, the rear keeps getting away on the uphill. That one is the car, and it goes on to diagnosis.*

Diagnosis sheet — copy it into your log

One sheet per change. It gathers in one place everything the four exercises asked for — and, reread after a few sessions, it shows what worked, what didn't, and why.

FIELD	FILLED-IN EXAMPLE · TURN 9 FROM THE EXERCISE CASE
Symptom	Rear gets away on the exit of 9, on throttle
Phase / speed	Exit · slow corner
Point in the stint	Every lap, from the first → it's balance, not thermal
Car or driver?	Every lap, same spot, also at eight-tenths → it's the car
Diagnosis	Differential too open: inside wheel spins away and triggers traction control
Change	Differential preload, one step up
Prediction	Less traction cut on exit. If the car runs wide, I've gone too far
Price accepted	Lazier rotation in slow corners — the chicane should get a little worse
Result	Confirmed · failed · no change — the rear stopped getting away and the traction cut almost disappeared

“

*If everything seems under control,
you're just not going fast enough.*

MARIO ANDRETTI · driver

True for a qualifying lap. For diagnosis, this module asked for the opposite: driving below the limit, on purpose, until you knew whether the problem was the car or you.

02

NEXT MODULE

Physics without math

The method demands a mechanical hypothesis before every change. To form one, you need to know what happens to the load on the four tires — and why almost everything in the garage exists only to move it.

END OF SAMPLE

That was the first of ten modules.

You've seen the loop and the falsifiable prediction. From here, Debrief gives you physics without math, the setup screen adjustment by adjustment — what each one does, which way to move it, and what it costs — tire reading, engine layout, track families, and the road from practice to the checkered flag.

107 A4 pages

10 modules, 7 appendices, exercises with sample answers

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