NNJR "Trackside Classroom" Series

Car Balance

Disclaimer

The techniques shown here have been compiled from experienced sources believed to be reliable and to represent the best current opinions on driving on track. But they are advisory only. Driving at speed at Mid-Ohio, or any other track, requires skill, judgment and experience. These techniques assume the reader has high performance driving knowledge and applies them as applicable to their level of driving experience.

High-performance driving can be very dangerous, carries inherent risks and may result in injury or death. NNJR and PCA make no warranty, guarantee or representations as to the absolute correctness or sufficiency of any representation contained herein. Nor can it be assumed that all acceptable safety measures are contained herein or that other or additional measures may not be required under particular or exceptional conditions or circumstances.

Its *All* about Balance !

- **Balance** = moving weight when, and where you choose to do so

- **Vic Elford**: “You will notice that professional drivers often act extremely quickly, but they are rarely in a hurry. Turning from a straight must be a smooth flowing transition into and then out of the corner.”

- **Jackie Stewart** (1985): “Senna is mellow on and off the throttle, calmly, smoothly, almost slowly.”

What Determines Balance?

1. Car setup
2. Track/car conditions
3. Driver inputs

1. Car Setup

- Modern Porsches are set up very well by Porsche
- Most DE cars have good handling
- At some point, all cars have handling “issues”, but
  - If you don’t feel them, focus on driving (it’s not the car)
  - You can’t judge them unless you are (very) consistent
  - If you feel them, start with a diagnosis
- For more, see appendix

Ross Bentley: How to Turn Your Car’s Handling

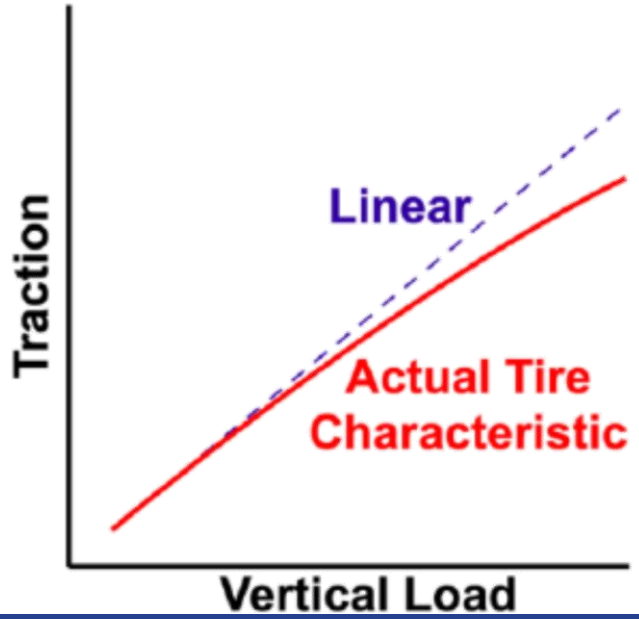
2. Track/car Conditions

- Obvious
  - Rain, cold, etc.
- Subtle
  - Ambient temp
  - Track temp
  - Tire condition: new, worn, etc.
  - Weight: passenger, full tank, etc.

- All must be addressed by driver inputs!

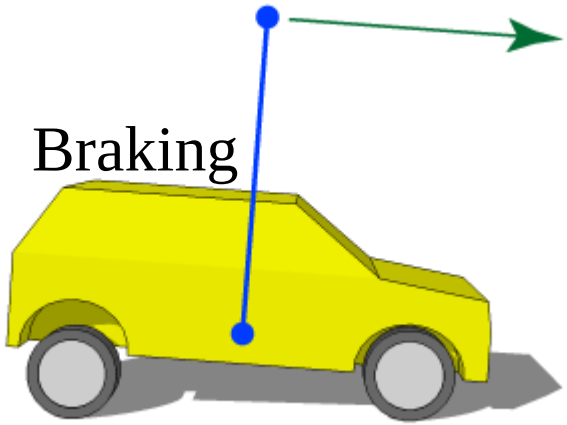
3. Driver Inputs = Weight Transfer

- Weight transfer (load transfer) is inevitable
- But…sudden is bad
  - Weight should move smoothly, and only once
- And…less is better
  - Cornering
    - Outside tire gain < Inside tire loss
  - Braking
    - Front tire gain < Rear tire loss

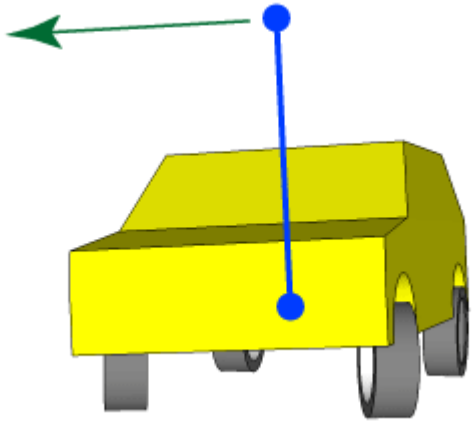


Weight Transfer Model

Braking: 300+ pounds per front tire !



Cornering: 500 pounds per outside tire !



Cornering

Rules of Thumb

Lateral Weight Transfer ≥ 30% of car weight

Braking Weight Transfer ≈ 20% of car weight

1000 lbs for a stock Porsche !!

Both are proportional to Weight, CG, and wheelbase/track inverse

Basics: Steering and Shifting

- Steering
  - Turn progressively and once: take a “set”
  - Always know where center is
  - Smooth: wind and unwind
  - Practice every day

- Shifting
  - Each shift upsets the car, takes time
  - Learn it the right way (3 steps)
  - Practice every day

Basics: Braking

- Critical part of balance, hardest to learn
  - Move foot smoothly (heel on floor)
  - Smooth but hard initial pressure
    - Push against pressure: 1, **2!**
  - Gentle Brake Release
- On track, brakes are <u>not</u> for stopping! They
  - Set entry speed for a turn
  - Determine car attitude
- Focus on the End of Braking

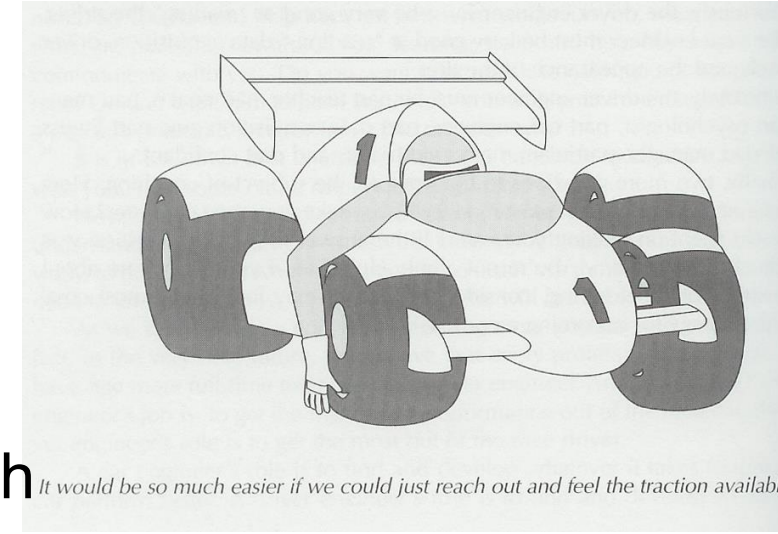
Mario Andretti: *"Its amazing how many drivers, even at the F1 level, think the brakes are for slowing the car down."*

Is Your Car Balanced?

- How close to the limit are you?
- Do you know if/when your car is understeering?
  - Oversteering?
  - Both (at different times)?
- *Do you know when PSM intervenes?*

Is Your Car Balanced?

- Sensing the car is a learned skill
- Sensory input sessions
  - Sound
  - “Seat of the pants” (Kinesthetics)
  - Feel in the steering wheel
  - Vision: car’s path vs. intended path



Causes of Understeer

- Insufficient weight on front tires due to:
  - Abrupt brake release (on entry)
    - *e.g. MidOhio Keyhole, T6; Watkins Glen T1, Toe, Heel; Lime Rock T1, Left Hander*
  - Too much gas, too soon (on exit)
    - *e.g. MidOhio Keyhole, T5, T6; Watkins Glen Toe, Heel, Off Camber; Lime Rock T2*
- Steering input too rapid or too much steering angle
  - *e.g. MidOhio T1, Watkins Glen T1*

How to Fix Understeer

- More/longer trail braking (maybe)
- Smoother Brake Release
- Smoother Turn-In
    - i.e. more progressive
- Be a detective
  - Why isn't enough weight on front tires?

Causes of Oversteer

- Too much trail brake
  - e.g. Most corners
- Rapid lift when car isn't straight
  - e.g. MidOhio T9
- Aggressive braking mid-turn
  - e.g. Most corners
- Too much power, too soon (high powered cars)
  - e.g. Most corners

How to Fix Oversteer

- Less trail braking (probably)
- Smoother brake release
- More progressive steering input
- Less and/or later gas (smooth!)
- Be a detective
  - Why isn’t enough weight on back tires?

Randy Pobst

- Understeer is slow
- Oversteer is scary!

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Balance Summary

- Most DE cars are setup reasonably well
- Large amounts of weight move on track
  - Inevitable
- The driver sets weight transfer
  - How much and rate
- Improving weight transfer improves traction
  - Requires smoothness with controls
  - Objective = **Balance**
- Learn to be a “weight transfer detective”

Questions?

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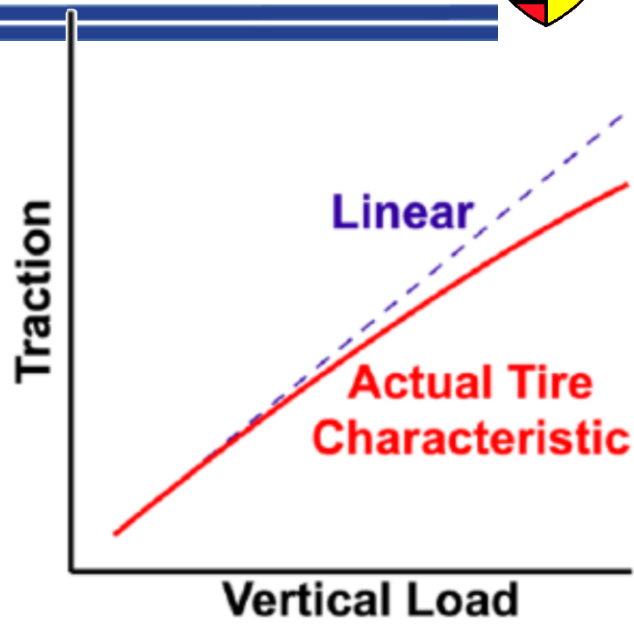
Appendix: Car Setup

Vehicle Dynamics

- Lateral loads (cornering) cause roll
  - With weight transfer
- More weight transfer = less grip
- Front vs rear roll stiffness is critical



- General rule: soften the end of the car that needs more grip
  - Anti-roll bars, springs, shocks
- Exception: too much roll (common) requires the opposite!

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Big Picture: “Principles”

- Balance is more important than overall grip
- Avoid pre-conceived ideas
- Copying an adjustment from someone else rarely works
- All cars have handling “issues”, but
  - If you don’t feel them, focus on driving (it’s not the car)
  - You can’t judge them unless you are (very) consistent
  - If you feel them, start with a diagnosis

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Car Setup Issues?

- Download and read this
  - https://speedsecrets.com/tune-car-handling/
- General setup tuning guidelines
  - 1. Make big enough changes that you're sure to feel
  - 2. Work with what you have (tools, adjustments)
  - 3. Do A-B-A tests
  - 4. Take notes
  - 5. Work on the end of the car that needs improvement - then the opposite if
  - you can't fix it
  - 6. Balance is more important than overall grip
  - 7. Learning what doesn't work is as important as what does
  - 8. Avoid pre-conceived ideas

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Weight Transfer (Load Transfer)

$$A = W \times \mu$$

A= Adhesion
W = Weight
μ = Coefficient of adhesion (surface)

Why do you care?

Traction is based on weight!

Car cornering at constant radius and constant speed

Formulas

- Lateral load transfer (lb) =

Lateral Acceleration (g) x center of gravity height (in.) x Weight(lb) ÷ Track Width (in)

- Longitudinal load transfer (lb) =

Acceleration (g) x center of gravity height (in) x Weight (lb) ÷ Wheelbase (in)