Topic One
How Laws of Nature Affect Vehicle Balance & Weight Load Transfer

Gravity
Kinetic Energy
Momentum
Inertia
Gravity is the natural force that constantly pulls all things to the earth and affects an object’s weight.

Center of Gravity is a point where the mass of the vehicle is concentrated and balanced.

The higher the center of gravity, the more unstable the vehicle becomes.

When a driver brakes, accelerates, or corners, the G forces are amplified.
Kinetic energy is the energy an object possesses due to its speed, or velocity \( (v) \) and its mass \( (m) \) : \[ KE = 0.5 \cdot m \cdot v^2 \]

The faster the object moves, the more energy it collects.

A heavier moving object will have more kinetic energy than a lighter object moving at the same speed.

A vehicle’s kinetic energy can be overcome by brakes, friction, air resistance and gravity.
The white truck and the dump truck are traveling at the same speed; Which vehicle has more momentum? Why?

**Momentum** refers to the quantity of motion an object has, measured in $\text{kg} \cdot \text{m/s}$

Formula: $p = m \cdot v$. The more mass and more velocity an object has, the more momentum

Change in momentum is called **impulse**; the magnitude of impulse is based on the amount of opposing force and the timespan over which that force is applied.
Inertia

A Vehicle’s Possible States of Motion

- Slowing down or Stopping
- Accelerating or Cruising
- Turning towards the Left
- Turning towards the Right

Inertia: an object’s tendency to resist any change in its state of motion. How is inertia affecting the positions of the people on the rollercoaster?

How is inertia affecting the position of the person driving the vehicle around the hairpin turn?
Inertia (cont.)

When driving through this curve, inertia creates the sensation that you are being pulled toward the outside of the curve.

Why?

Because you are traveling in a straight line, and inertia wants to keep you going in a straight line.
Controlling Vehicle Balance
Changing the Vehicle’s Center of Gravity

What transfers weight from one point of the vehicle to another?

- Acceleration
- Deceleration/Braking
- Steering Input/Cornering
- Surface Traction

Pitch
Roll
Yaw
Controlling Vehicle Balance
Steering Input

Click the link to watch this video of a professional stunt car driver use the, “shuffle,” or “push-pull-slide” steering method:

Steering Input Video

Controlling Vehicle Balance Pitch

“Pitch”
Vehicle Shifts Weight from Front to Rear or Rear to Front

Forward Pitch
Changing Weight From Rear to Front
- Release Gas Pedal
- Brake
  - Slowing down shifts weight to front tires

Backward Pitch
Changing Weight from Front to Rear
- Release Brake
- Accelerate
  - Speeding up shifts weight to rear tires

Which is demonstrated above?

a). Forward Pitch
b). Backward Pitch
Three Factors that Factor in Creating Vehicle Roll:

- **Steering Wheel Movement**: Sudden jerky steering will throw the vehicle’s weight to the inside tires of the direction you steer.

- **Brake Application**: Certain braking/steering combinations can be used to minimize roll while navigating a sharp or long turn.

- **Grade of the Road**: Although interstates are mostly flat, smaller roads sometimes slope downward on the sides with the highest point in the middle.
Controlling Vehicle Balance

**Yaw**

Vehicle Rear-Load Transfers to the Left, Right, or Back and Forth

Factors that Affect Rear-Load Transfers to the Right/Left:

- Sudden braking
- Sudden/excessive acceleration
- Sudden/excessive steering
- Traction loss to either the left or right rear tire
- Road is tilted to either the right or left

This race car is making a left turn at a high speed on a loose, dirt road which has resulted in yaw to the right.
Topic Two
Vision and Driving
Vision
The eyeball’s ability to distinguish the number, shape, and color of an object.

Perception
How we interpret and understand information gathered by any of the five senses.
What do you see?
Your Eyes are Critical to Driving

Drivers Base Driving Decisions on:
- About 90% on what they see.
- About 10% of all on what they hear or feel.

Drivers:
- Search at least 20 seconds ahead in your path of travel to evaluate the situation and make good decisions about speed, lane position, signs, signals, markings, and potential hazards.
What Kind of Visual Input is Relevant to the Driver?

Information that dictates or could affect how you navigate your path of travel.

- What they are expected to do.
- What they are prohibited from doing.
- Changes in road/lane structure.
- Potential hazards.
- Location of common public destinations.

Signs, Traffic Signals, and Lane Markings inform drivers of:
What Kind of Visual Input is Relevant to the Driver?

Information that dictates or could affect how you navigate your path of travel.

- Relative location, direction and speed of other vehicles.
- Displays of aberrant behavior by other drivers.
- Weather and road conditions.
- Presence of/areas where pedestrians, children, and animals may be.
Do THE TEST

https://www.youtube.com/watch?v=tNGwGGjijfY
“The eyes don’t tell the brain what they see; The brain tells the eyes what to look for.”

Want to become a good driver?

You have to spend TIME behind the wheel and actively PRACTICE visual searching skills!
The Three Visual Fields

**Focal Vision**
- 1.5 – 3° in the center of vision field.
- Allows you to read/see details.

**Paracentral Vision**
- 8° in the center of the vision field.
- Allows you to maintain path of travel.

**Peripheral Vision**
- More sensitive to light and motion.
- Orients individual to environment.
Diagram of the Human Field of Vision

Paracentral Vision

1.5° to 3° Focal Vision

Near peripheral: 30°
Mid peripheral: 60°
Far peripheral: 90° to 100°
Visual acuity tests measure the level of detail your eyes can see, (individually, and together), in optimal light conditions.

**Nearsighted**: Able to see near things more clearly than distant ones.

**Farsighted**: Able to see distant things more clearly than near ones.
Seeing at Night

Hazards

Lack of light drastically reduces field of vision, visual acuity, depth perception and color recognition.

Nocturnal and crepuscular wildlife become active.

Inner and outer sources of concentrated light cause glare.

People driving at night are more likely to be fatigued.

People driving at night are more likely to be intoxicated.
**Seeing at Night: Compensation Strategies**

**Darkness**
- Drive slower to allow more time to react.
- Use Focal and Paracentral Vision.

**Glare**
- Oncoming headlights: Avert your gaze to line painted on right side of road.
- Internal light: keep it dark in the vehicle when it’s dark outside.
- Sunbeams: keep windows, headlights, and signal lights clean inside and out.

**Animals**
- Use your high-beams on rural roads.
- Pay attention to animal crossing signs.

**People**
- Watch for erratic driving behaviors from other vehicles on the road.
- Stay away from drivers exhibiting signs of distraction, intoxication, or fatigue.
Other Factors that Affect Visual Perception

Glare
Fatigue
Drugs/Alcohol
Weather
Darkness
Speed
Inattention

Smoke
Age
Dirty Windshield
Poor Windshield
Wipers
Poor night vision
Night Blindness
Speed Affects Vision

Hazards that increase with increased speed:

• Drivers have less time to see and react.
• Minor steering movements cause exaggerated vehicle movements and weight shift.
• Speed distorts and reduces Peripheral vision up to 90%.

Compensation Strategies to use at Higher Speeds:

• Train your eyes to look farther ahead—you’re covering ground faster.
• Allow more space between your vehicle and others.
• Actively move your eyes from one side of the path of travel to the other to search for relevant information and hazards.
Need both eyes to perceive depth (3D distance).

Allows you to judge gaps, speed, and distance of other vehicles and hazards in the traffic environment.

Essential when passing, approaching a vehicle or hazard; turning, merging, and crossing intersections.

To judge the distance between vehicles, look at where the tires contact the road, not the body of the vehicle.
Driving Mistakes that Indicate Poor Depth Perception

- Stopping too far from the stop line or intersection.
- Stopping too close to vehicles ahead.
- Moving into gaps that are too small.
- Looking for gaps that are larger than needed to perform a maneuver.
- Following other vehicles at unsafe following distance.
- Hitting parked cars when parking.
- Having “close calls” when entering traffic, passing, etc.
Ways to Improve Your Field of Vision

- Clean windows—inside and out
- Clean vehicle’s outside lights and be sure they work
- Inspect wiper blades for damage and effectiveness
- Adjust mirrors properly
- Remove objects that interfere with vision
- Keep sunglasses and windshield scraper in vehicle

Tips for improving your field of vision through vehicle maintenance.
Establishing a Safe Lane Position

- Line of sight
- Targeting
- Blind Spots
- Lane Positions
- Vehicle Reference Points
Line of Sight (LOS)

Line-of-sight is the visible path of travel from your vehicle to the target area. When something obstructs your LOS, you may need to adjust your speed and/or position until it is clear again.
Path-of-Travel (POT)

Path-of-Travel is the series of continuous positions your vehicle will occupy while traveling toward your target area.
Selecting a Target

Target

- Specific object
- Located straight ahead in the center of your path of travel
- Near visual field limit
- Steer towards
- Changes to whatever appears in the center of your path of travel

Do not stare at or fixate your gaze on the target itself...
Rather than focusing directly on the Target, continuously scan to the left and right of it (the Target Area) for relevant information and potential hazards.
Lane positions are based upon an average lane size of 12-feet wide, and a vehicle 6-feet wide. This Diagram shows the three basic lane positions drives can use. Select the lane position that gives you the best line of sight and safest path of travel.

Using Lane Position to Maximize Your Line of Sight
Lane Position 1

Positioned in the center of lane with an equal buffer of space on either side.
Standard Vehicle Reference Points for Lane Position 1

**LEFT Reference Point**
- 3 feet from pavement line or median

**RIGHT Reference Point**
- 3 feet from pavement line or median

- Relates a part of the vehicle to some part of the roadway.
- Know your vehicle placement within a lane at all times.
- Maneuver in confined places.
Lane Position 2

3-6 Inches

Allows for additional space to the right of the vehicle. Used to prepare for a left turn or when avoiding a problem to the right of the vehicle.
LEFT Reference Point: Vehicle is 3-6 inches from the pavement line or median.

Preparing to make a left-hand turn.

Determining position for parking on the left side of a one-way street.

RIGHT Reference Point: Vehicle is 3-5 feet from curb, pavement line, or edge of road.
Lane Position 3

Allows for additional space to the left of the vehicle. Used to prepare for a right turn or when avoiding a problem to the left of the vehicle.
Standard Vehicle Reference Points for Lane Position 3

LEFT Reference Point: Vehicle is 3-5 feet from the pavement line or median

RIGHT Reference Point: Vehicle is 3-6 inches from curb, pavement line, or edge of road

Preparing to make a right-hand turn

Determining position for parking on the right side of the street
In the figure above, the green cars represent the size and areas of pavement that the driver of the white car cannot see.
Standard Vehicle Reference Points: Front Limitation

1. As the vehicle approaches the white stop line, the driver will lose sight of the segment of line directly in front of the vehicle: so how does the driver know when to stop at the right place?

2. The driver should look out the right front window and allow the vehicle to creep forwards until the white line is directly under the passenger side mirror.

3. This reference point will help you direct your vehicle to a stop, with the nose of the bumper positioned just over the beginning of the stop line.
Standard Vehicle Reference Points: Rear Limitation

1. When you look back over your right shoulder, the curb should appear to intersect near the lower right side of the right rear window.

2. When you look back over your left shoulder, the curb should appear to intersect with the lower middle of the left rear window.

3. Using these reference points will allow you to back up to a curb, leaving an appropriate distance between it and your bumper.
Holding the upper half of the wheel can result in excessive steering, air bag injuries, and upper body fatigue.

Benefits to keeping your hands on lower half of the wheel:

- Puts the body in a natural position with relaxed shoulders.
- Promotes balanced control of the steering wheel, reducing excess motion.
- Improves stability by lowering the body’s center of gravity.
- Prevents arm injury if the airbag deploys.
Hand-to-Hand/Push-Pull Steering

To turn RIGHT:

Left hand pushes up from 8 o’clock to 11 o’clock

Right hand pulls down from 1 o’clock to 4 o’clock
Hand-Over-Hand Steering

Used at Speeds below 15 mph

Used for slow, tight turns - Arms cross on the top 1/3 of the wheel until desired path of travel is reached.

Left Turn/left hand
Left hand pulls down, then reaches up to about the o’clock position and continues to pull 11-12 down to the left.

Left Turn/right hand
Right Hand pushes up to about the 11 o’clock position.
One-Hand Steering

- Backing a trailer—hand holds bottom of wheel
- Backing straight—hand holds top of wheel—Your right arm goes behind the front passenger seat.
Covering the Accelerator

Used for a smooth transition from braking to accelerating.

Allows the vehicle to coast which may speed up or slow down the vehicle.

Permits the driver to be prepared for any needed acceleration.

...you go ahead, I'm coasting.
Acceleration Techniques

Progressive, Smooth Acceleration

- Heel pivots foot from the brake pedal to the accelerator.
- Gently apply pressure to the accelerator pedal to gradually increase speed to minimize backward pitch and maintain vehicle balance.

Thrust Acceleration

- Typically used when passing or merging into higher speed traffic.
- Greater pressure is applied to accelerator pedal to rapidly increase speed without losing tire traction.
Braking Techniques

• Is a trait of a skilled driver.
• Saves gasoline, and wear and tear on the brake system and tires.
• Use ball of your foot to press pedal.

Smooth Braking Technique
Methods to Reduce Speed

1. Release the Accelerator Pedal

• Most frequently used method to slow vehicle speed.
• Gradually reduce pedal pressure to avoid abrupt changes in speed.
2. Controlled Braking

- Check the rearview mirror for vehicles coming up quickly behind you.
- Release accelerator and gradually apply smooth, steady pressure on the brake pedal.
- For a smooth stop, gently ease off the brake a few seconds before stopping to reduce the vehicle’s weight shift so the car does not pitch forward then backward during the final phase of stopping.
3. Threshold Braking in an Emergency

• Slows the vehicle as quickly as possible without locking brakes or losing traction.
• Release accelerator while checking for traffic behind you.
• Exert forceful pressure on the brake pedal; you will feel the vehicle’s weight shift forward.
• If you feel the wheels beginning to slide, ease off of the brake pedal so the tires can start rotating again.
Methods to Reduce Speed

4. Trail Braking

- Used for sharp turns.
- Occurs at the transition point where you slightly reduce pressure on the brake pedal to allow the vehicle to begin to regain speed before applying the accelerator.
Methods to Reduce Speed

1. Use controlled braking prior to reaching the curve.

2. Begin easing off brake, and trail brake with very light pressure until halfway through the turn.

3. Accelerate out of the turn.
A speed limit is the maximum legal speed you can travel on a road under ideal conditions. You may drive slower than the posted speed, but it is illegal to drive any faster. By law, you must drive slower if conditions such as road construction or bad weather make the posted speed unsafe. It is illegal to use a radar detector in Virginia.
## Maximum speed limit for passenger vehicles and motorcycles (unless posted otherwise)

<table>
<thead>
<tr>
<th>Type of Highway Zone</th>
<th>Speed Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interstate highways in certain rural areas</td>
<td>70 mph</td>
</tr>
<tr>
<td>Non-rural interstate highways, public roads not part of the interstate system</td>
<td>55 mph</td>
</tr>
<tr>
<td>Rural rustic roads</td>
<td>35 mph</td>
</tr>
</tbody>
</table>

School, business and residential zones (You are required to travel 25 mph in a school zone **only when indicated by sign or signal**. Otherwise maintain the posted speed.)

25 mph
Stopping Distance

Three factors determine the distance that it takes to stop your vehicle:

- **Perception time**: The time it takes you to recognize a hazard.
- **Reaction distance**: The distance your vehicle travels between the time you recognize a problem and the time you apply the brakes.
- **Braking distance**: The distance your car travels after you apply the brakes.
Average stopping distance on dry, level pavement

Source: Code of Virginia section 46.2-880
Speed Quiz

1. Can you drive slower than the posted speed limit?
2. Do you have to go 25 mph in a school, business or residential zone?
3. What is the speed on a rural highway?
4. Can you assume that the maximum speed limit on all public roads is 60 mph?
5. When traveling 65 miles per hour on dry, level pavement, it takes the average vehicle over 500 feet to stop.

6. The maximum speed limit for passenger vehicles and motorcycles on rural rustic roads is 35 mph (unless otherwise posted).

7. The maximum legal speed you can travel on the road in wet conditions is the speed limit.
Stopping

Describe at least 10 situations that you must always stop your vehicle.
Check Your Knowledge

1. At flashing red signals, you must always stop your vehicle.

2. A law enforcement officer signals for you to stop your vehicle. You ignore the officer's signal and the officer pursues you. As a direct result of the pursuit, the officer is killed. You will be:

3. When a school bus is loading or unloading passengers and the signals are not on, you do not have to stop.
Anti-Lock Braking System (ABS)

ABS allows maximum stopping force without locking up the brakes (skidding).

If standard brakes are applied too hard, the wheels "lock" or skid, and you lose steering control.

STOMP
Firmly depress the brake pedal.

STAY
Don’t pump the brakes!

STEER
Steer where you want to go.
If steering control is lost, the vehicle skids in a straight line wherever it is going. ABS is an anti-lock/anti-skid brake system that allows the driver to steer during hard braking.
The ABS warning will come on when there is a problem with either the ABS brake system, normal brake system, or the brake fluid is low in the master cylinder or the ABS brake system. To find out if a vehicle is equipped with ABS, turn on the ignition and check the instrument panel for the ABS indicator light.
In a parking lot, go 20-25 mph and execute an emergency stop to engage ABS. Keep your foot firmly on the brake even when you feel the brake pulsate and/or hear noise. This computerized pumping action can pump the brakes up to 15 times per second.
The brake pedal will vibrate when ABS is engaged.

TRUE

Many drivers release the pressure on the brake pedal when they feel the vibration.

Taking your foot off the brake disengages the ABS.
Check your Knowledge

1. What factor affects perception time, reaction distance and braking distance?
2. Radar detector use is illegal in Virginia.
3. In areas without a speed limit sign, the speed limit in a residential area is:
4. In areas without a speed limit sign, the speed limit in a business area is:
Please

Drive safely.