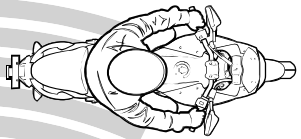
Motorcycle Crashes and Some Guidance to Avoid Them

Mac McCall
VTTI Motorcycle Research Group
September 28, 2017



Advancing Transportation Through Innovation

Virginia Tech Transportation Institute

Why?

- 2015
  - 4,976 killed
    - 29X more likely than in cars per mile traveled
  - 88,000 injured
- What do you think causes death and injury for motorcyclists?

Research Types

Experimental

Controlled Lab, Test Track, Simulator

VTTI Work with Rider Technologies and Alerts

Naturalistic

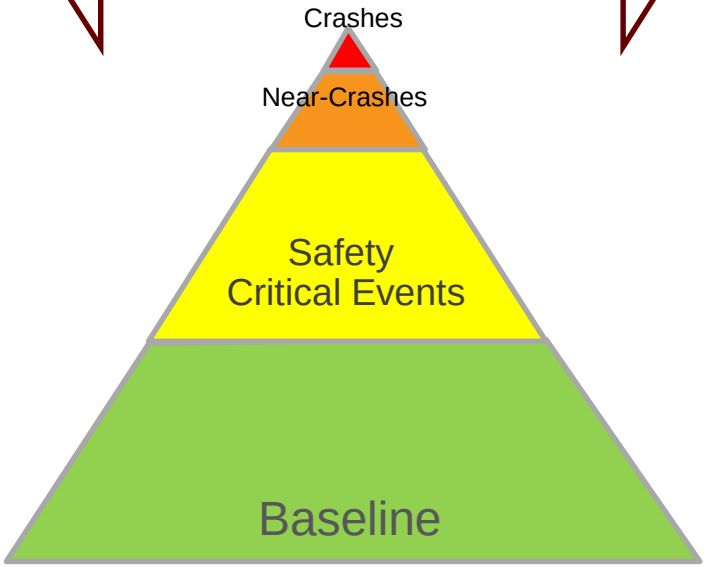
VirginiaTech Transportation Institute

MSF 100, NHTSA 160

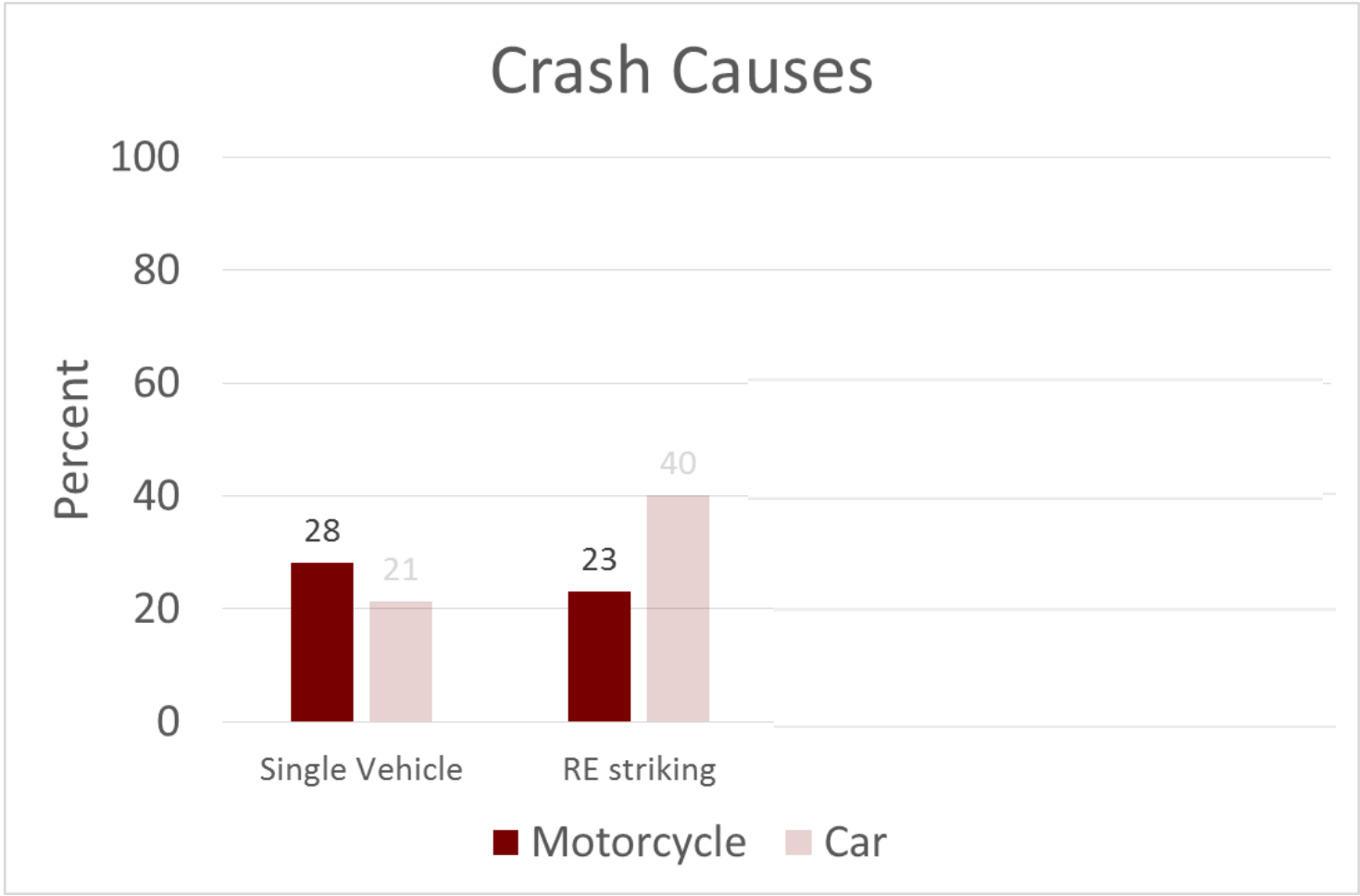
Epidemiological

Large Scale Reporting

FARS, GES, Crash Reports

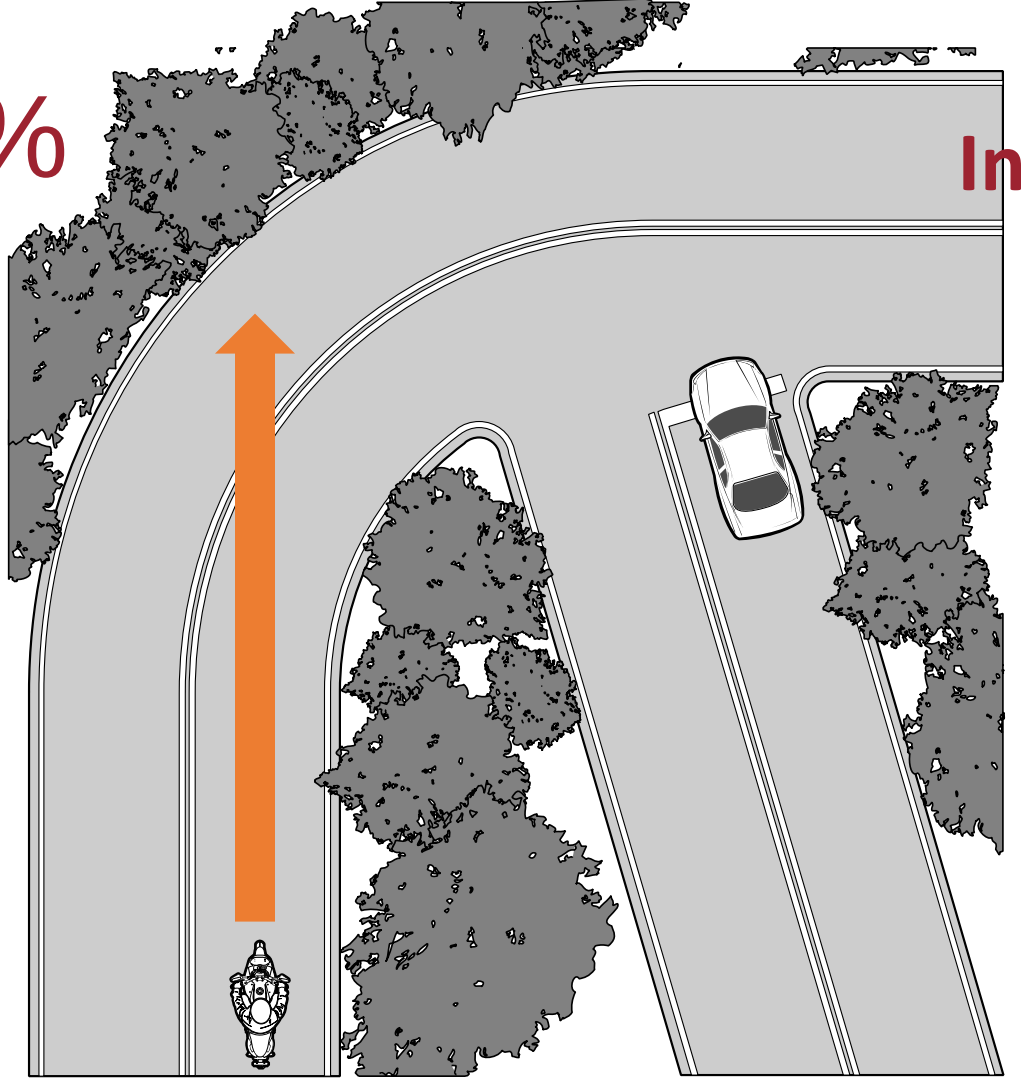


VTTI Experimental



FARS and NASS/GES 2001-2012 thanks to Jackey Chen for analysis

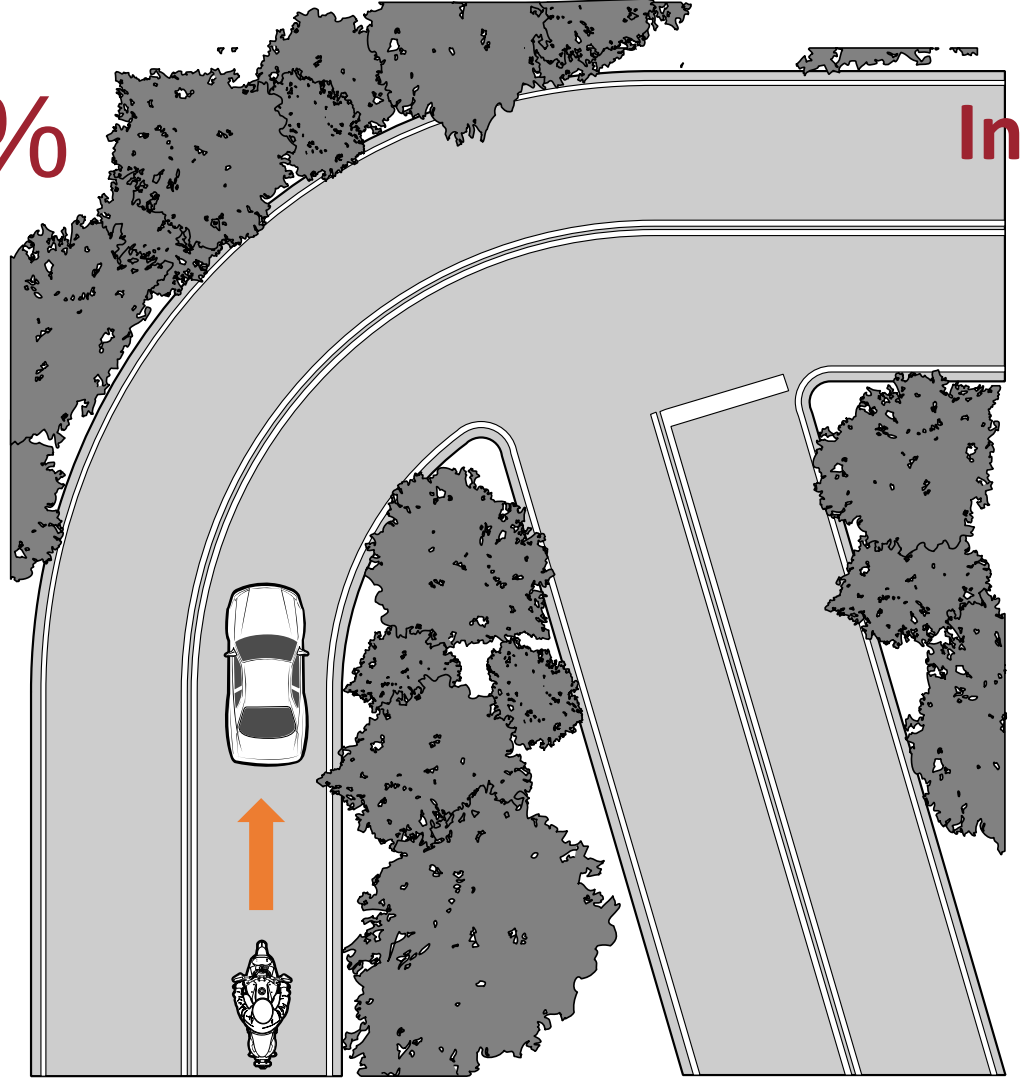
28%



Interventions

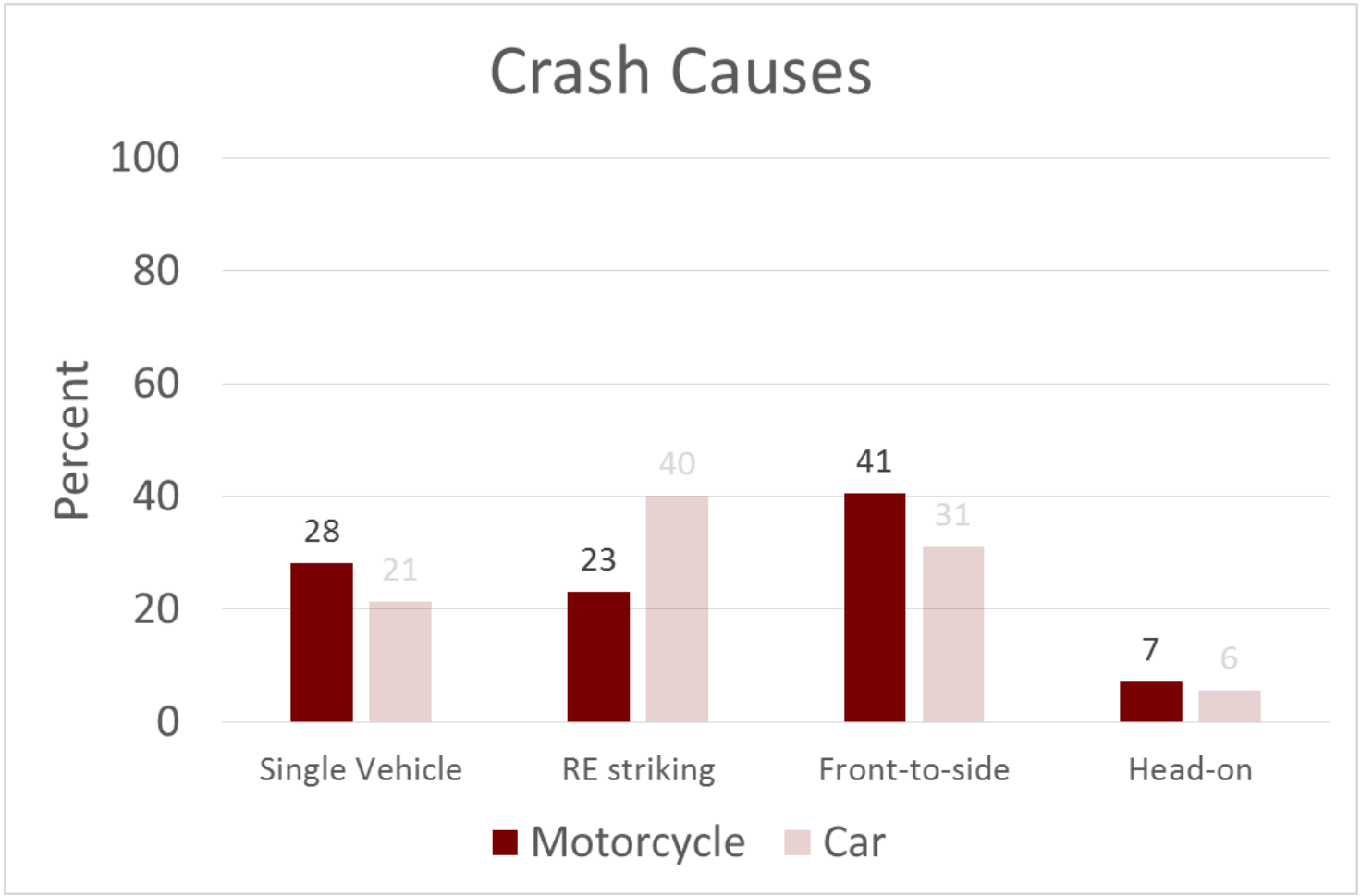
- Reduce speed
- Maintain proficiency
- Maintain humility
- Don't drink and ride

23%

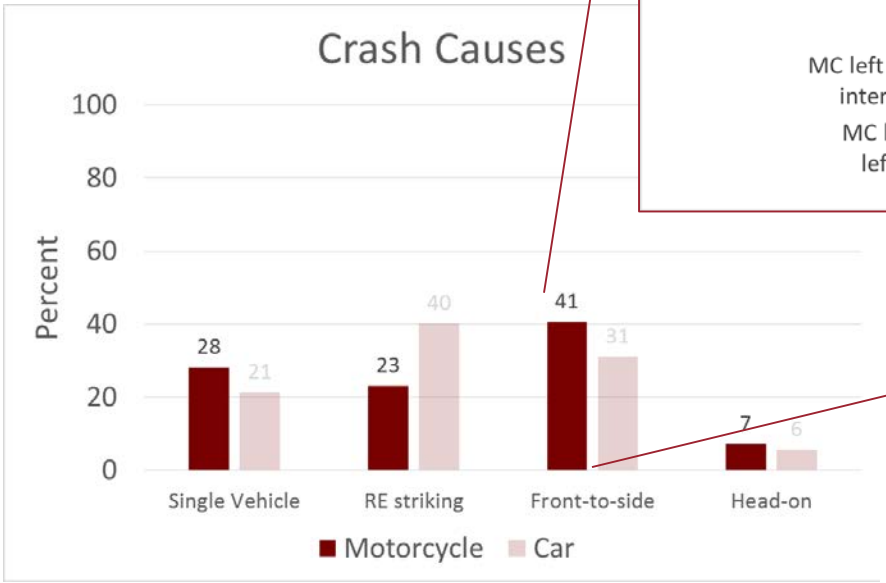


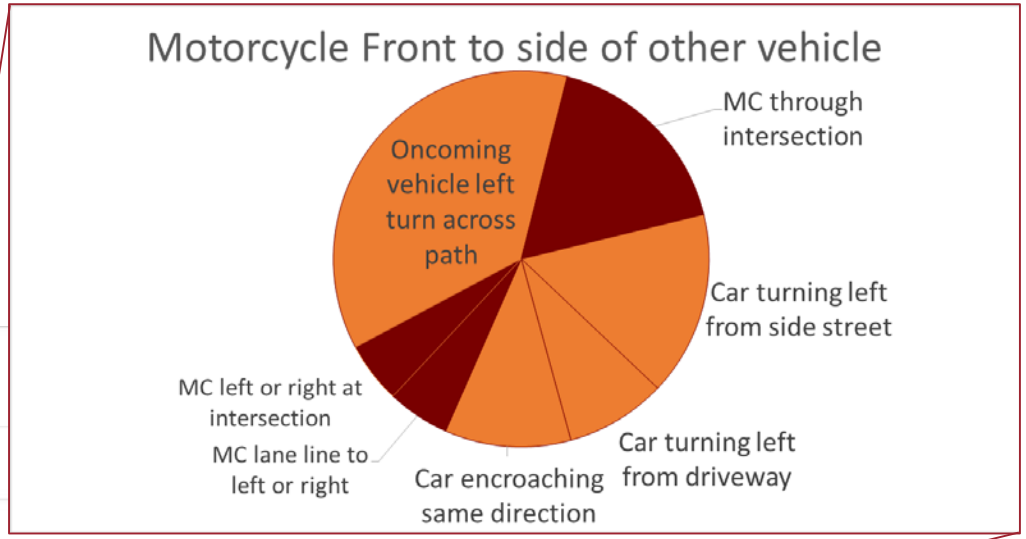
Interventions

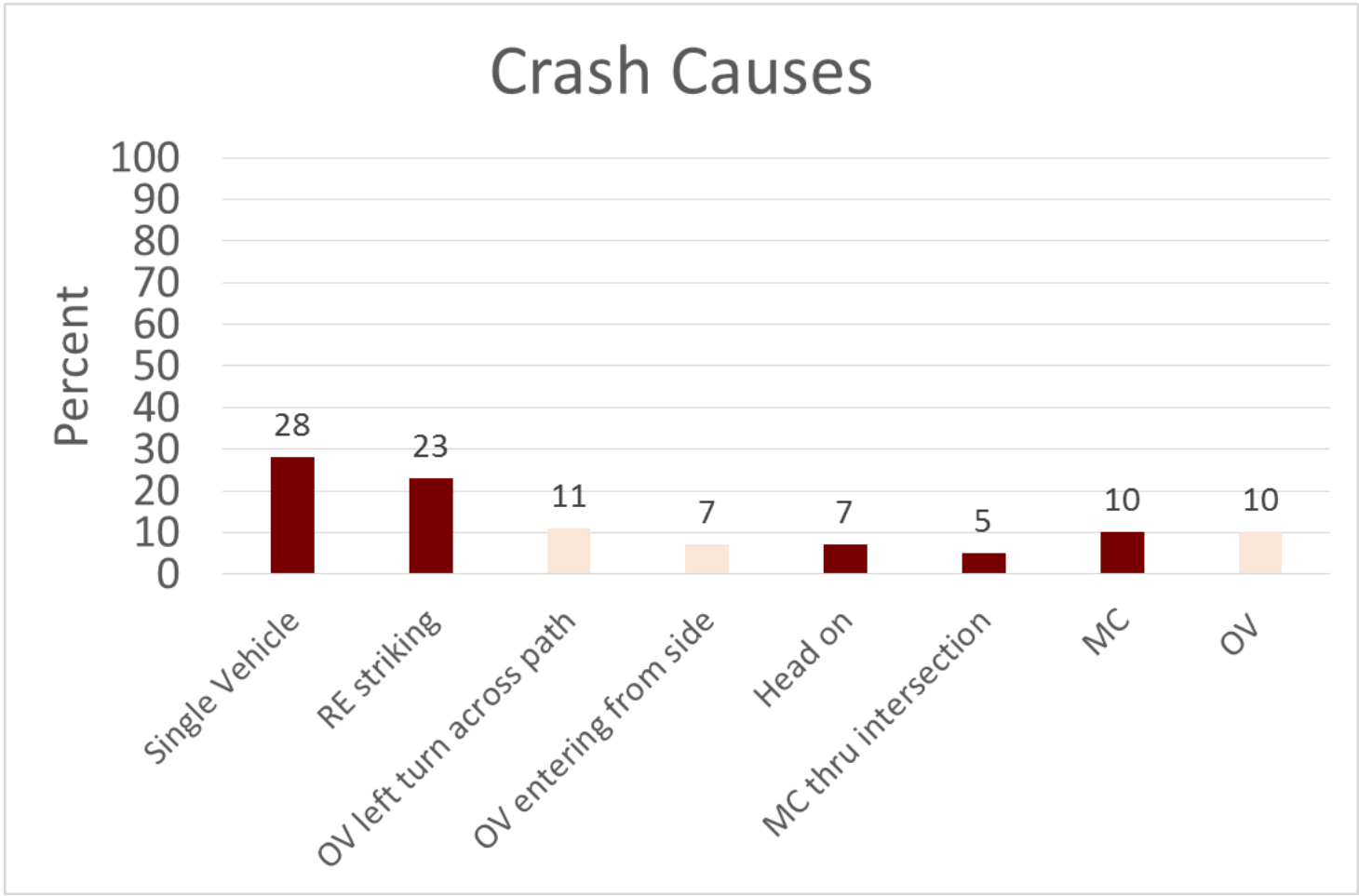
- Increase following distance further than you would in a car
- Recognize flow instability
- Maintain proficiency
- Maintain humility
- Don’t drink and ride


Crash Causes
100
80
60
40
20
0
Percent
28
21
23
40
41
31
7
6
Single Vehicle
RE striking
Front-to-side
Head-on
Motorcycle
Car

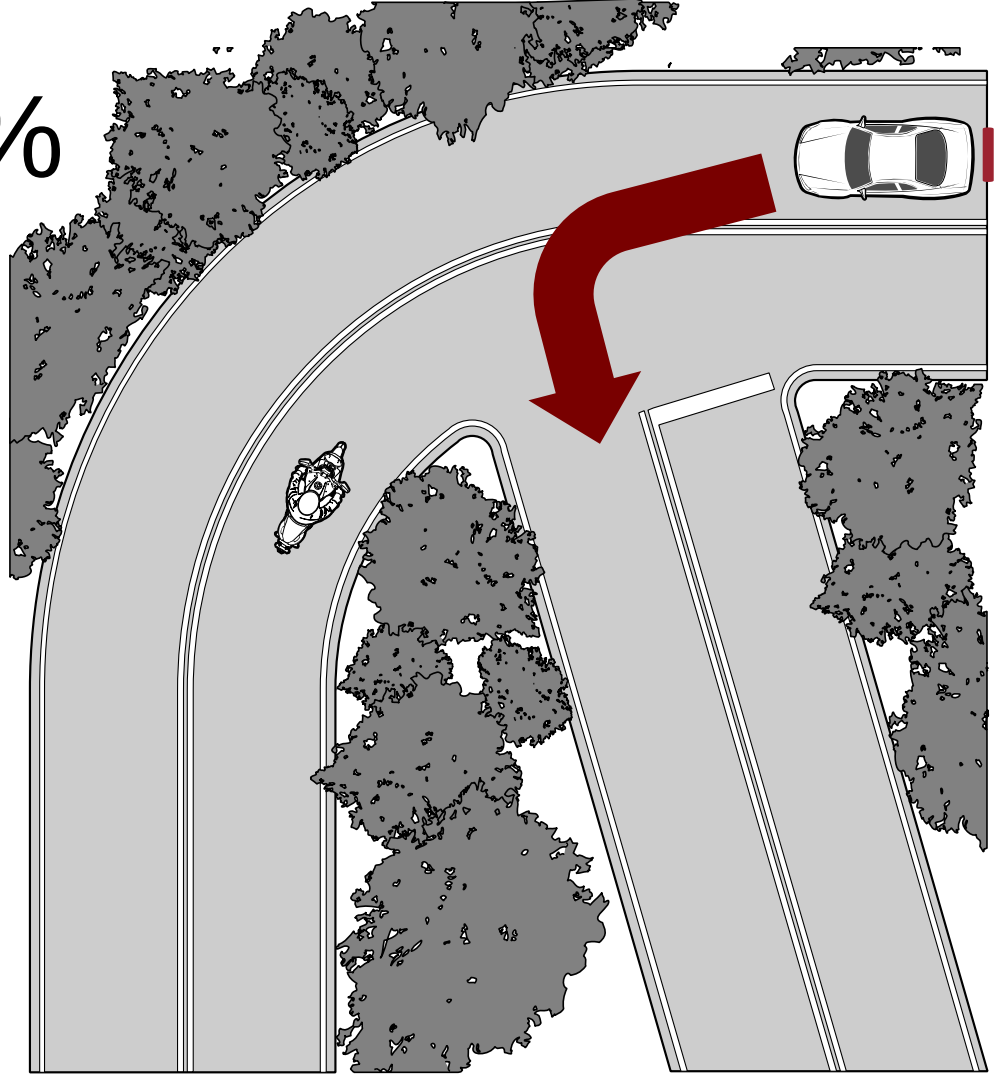
Digging Into Statistics






Crash Causes
Percent
100
90
80
70
60
50
40
30
20
10
0
28
23
11
7
7
5
10
10
Single Vehicle
RE striking
OV left turn across path
OV entering from side
Head on
MC thru intersection
MC
OV

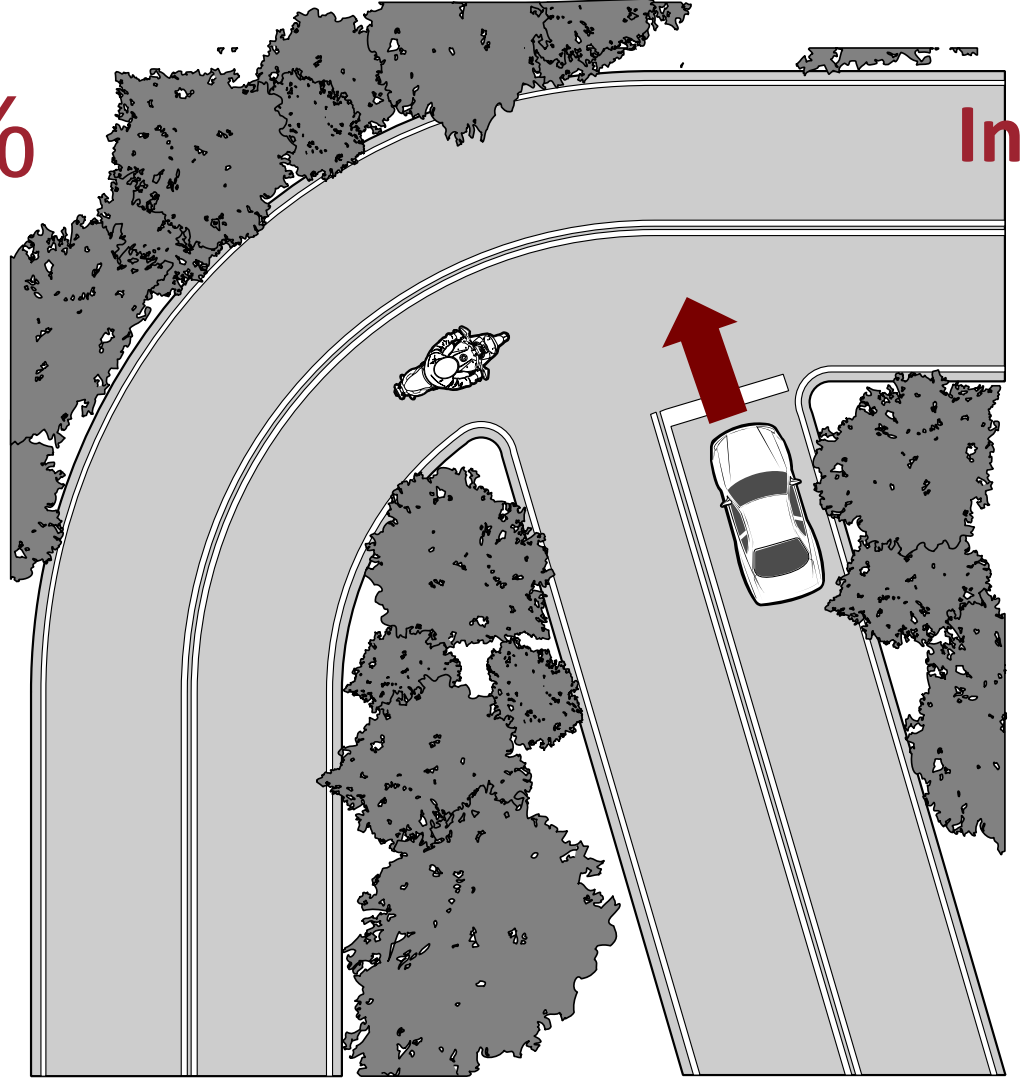
11%



Interventions

- Increase conspicuity.
- Don't speed.
- Expect the worst and have a real plan.
- Cover your brakes
- Slow down

7%



Interventions

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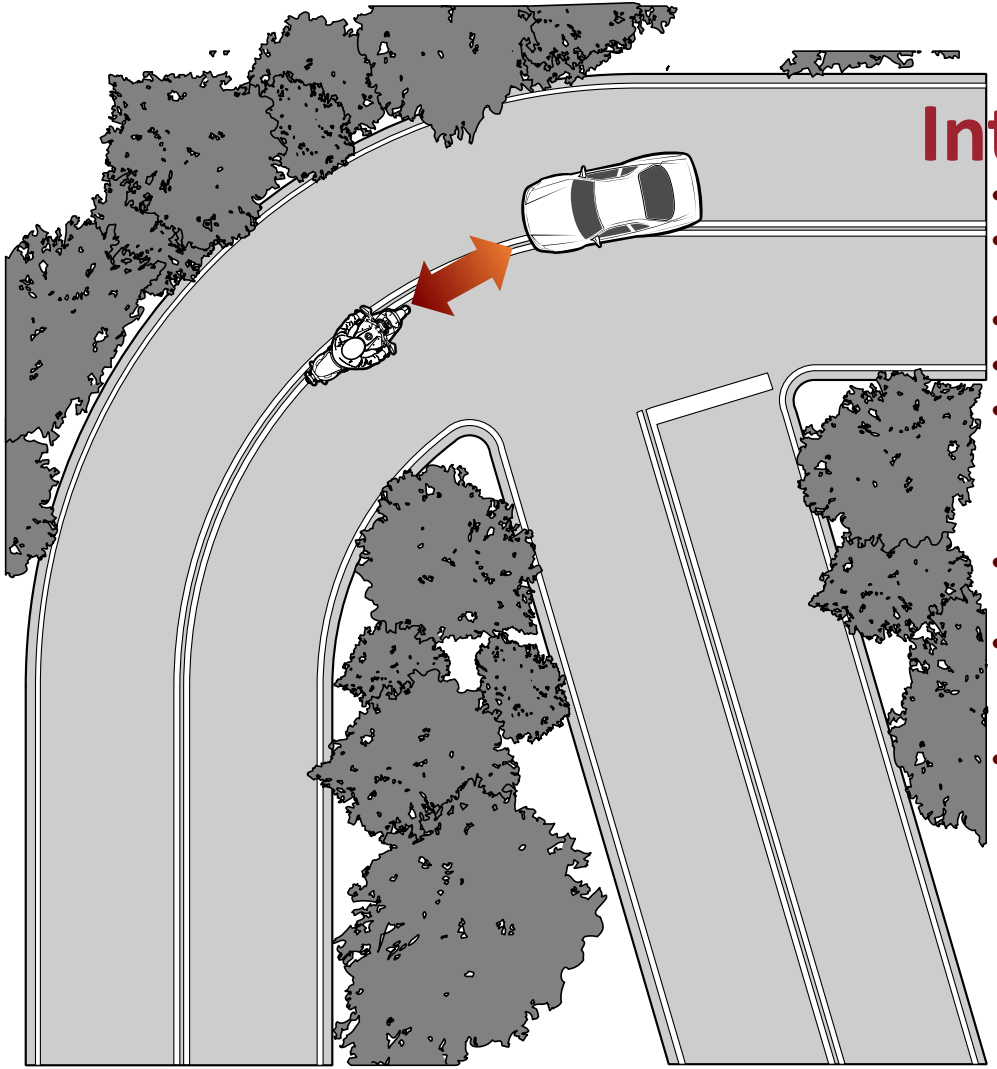
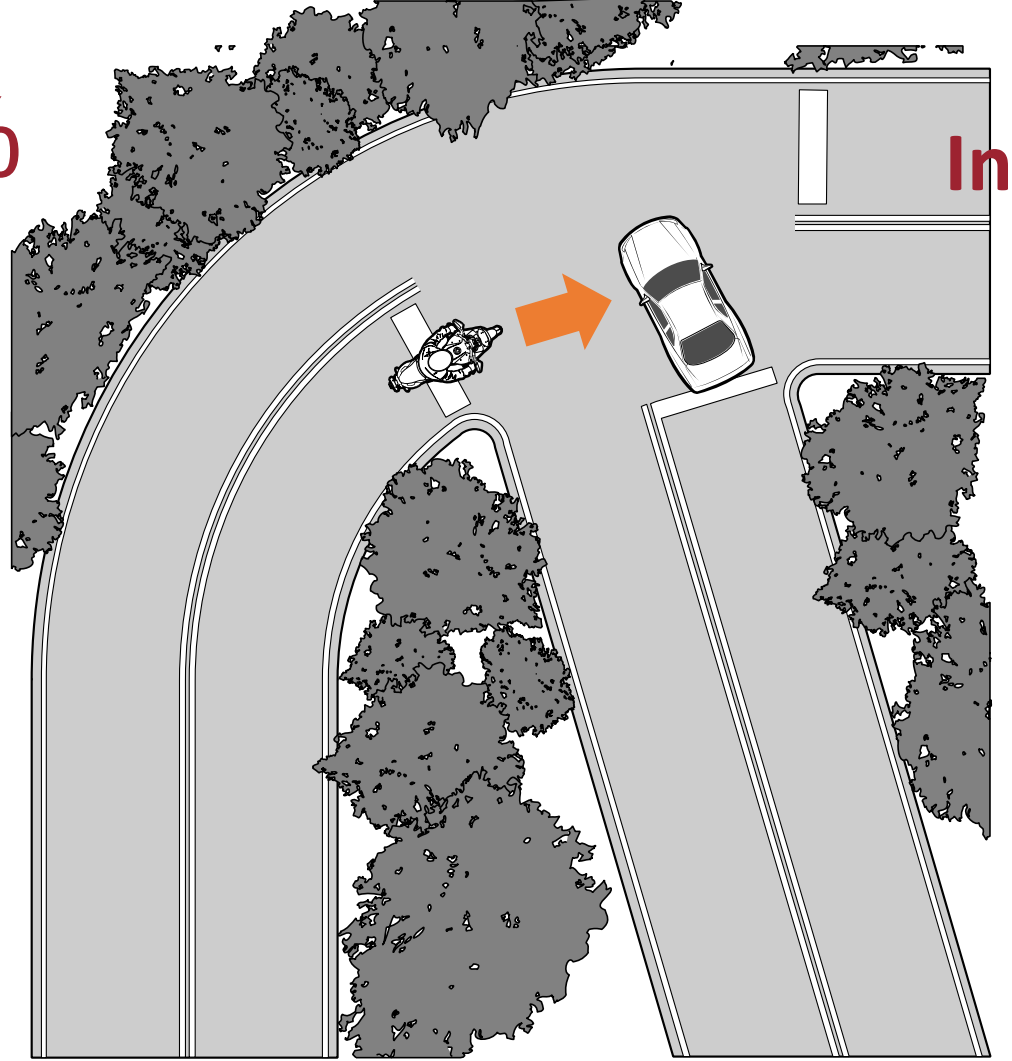
7%



Interventions

- Reduce speed
- Maintain proficiency
- Maintain humility
- Leave an Out
- Pick your passing situations very carefully.
- Increase conspicuity.
- Expect the worst and have a real plan.
- Don’t drink and ride

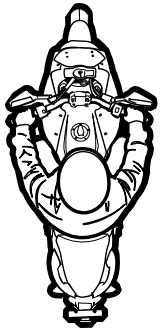
5%



Interventions

- Don’t speed
- Expect the worst and have a real plan.
- Maintain proficiency
- Don’t drink and ride

Miscellaneous



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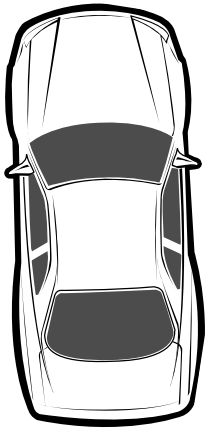

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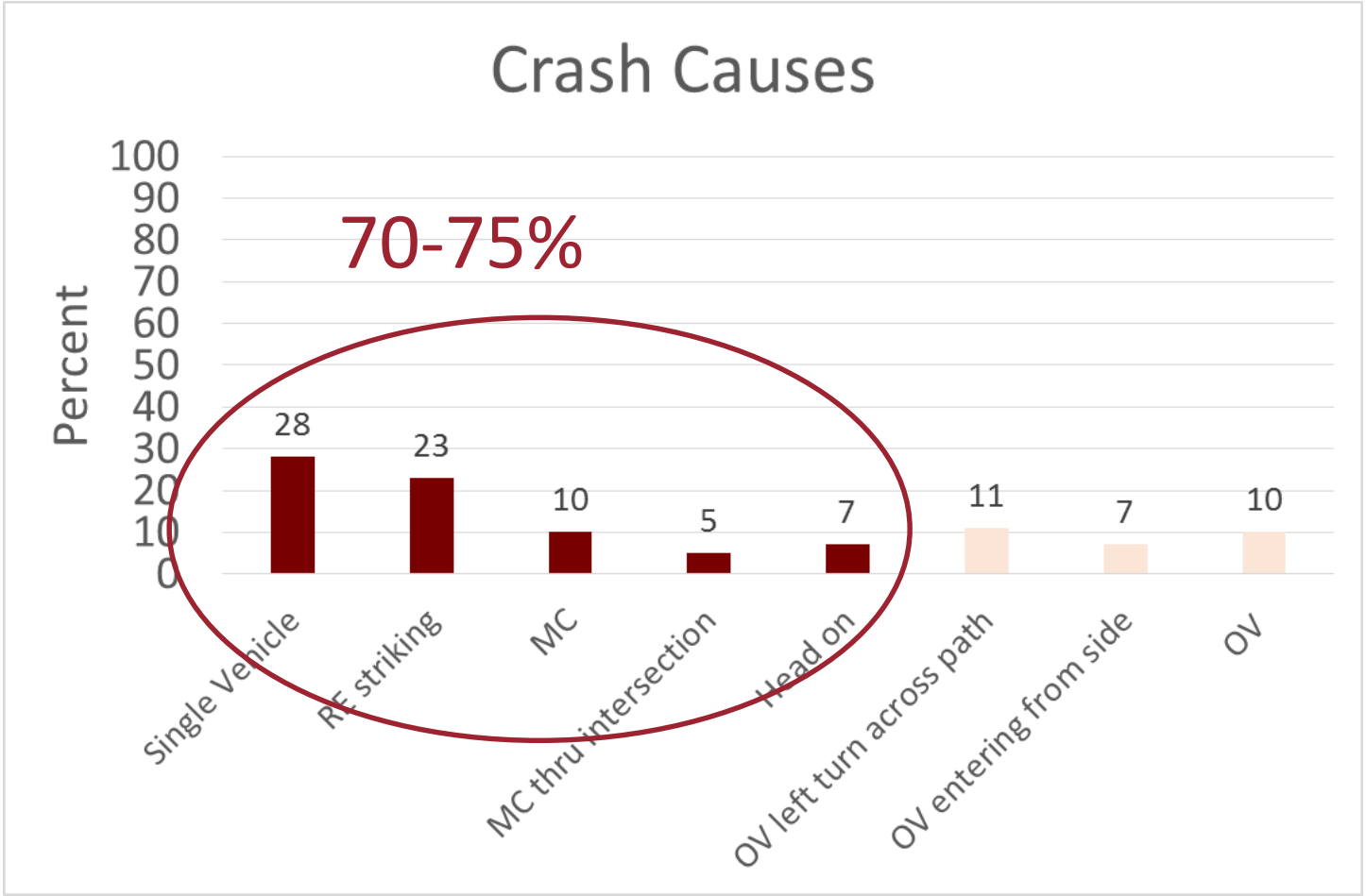
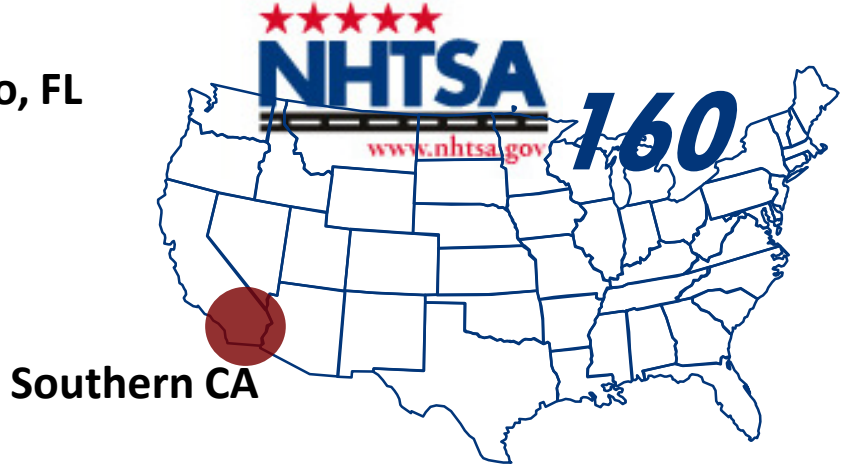
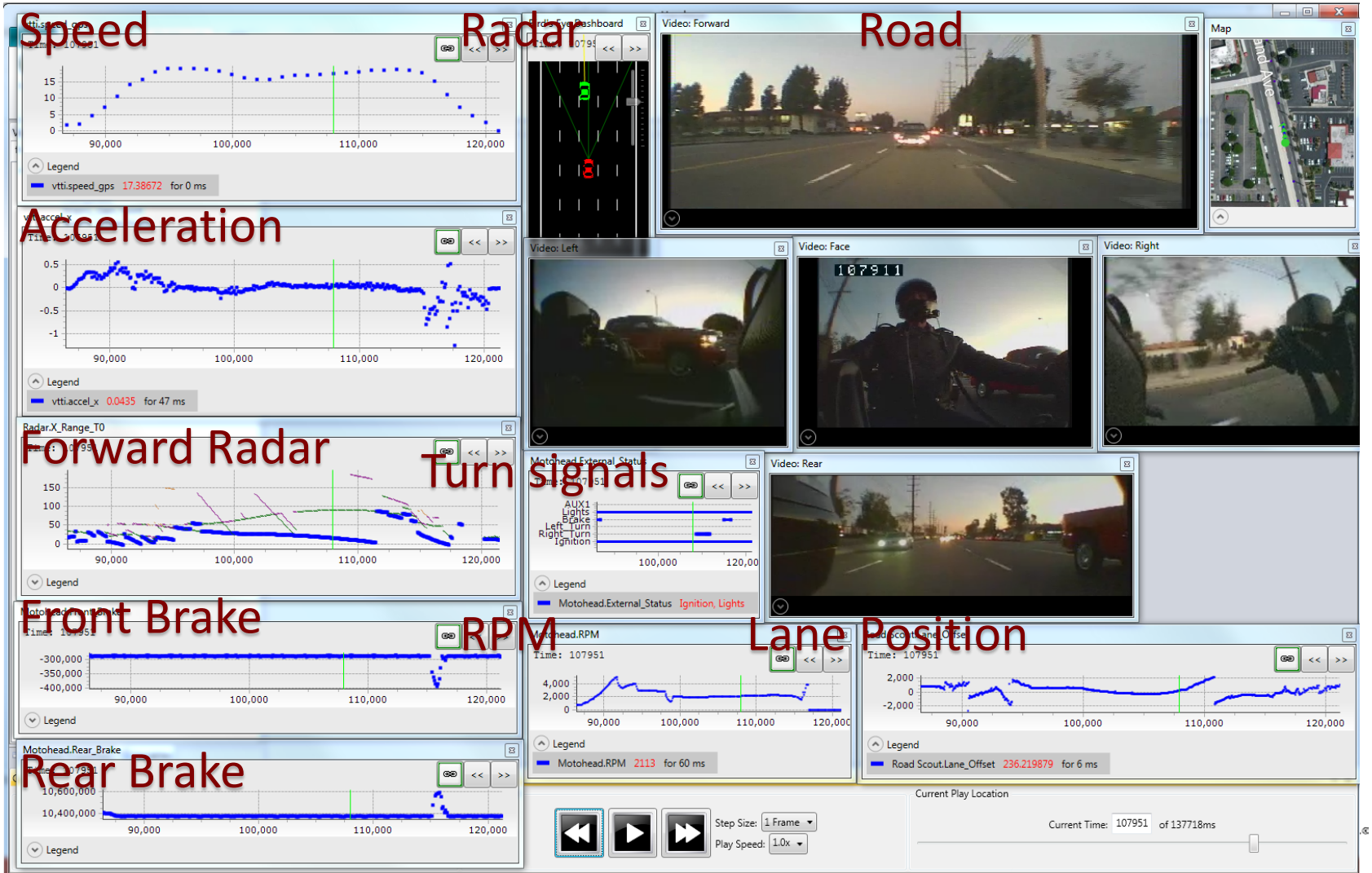

Crash Causes
Percent
100
90
80
70
60
50
40
30
20
10
0
70-75%
28
23
10
5
7
11
7
10
Single Vehicle
RE striking
MC
MC thru intersection
Head on
OV left turn across path
OV entering from side
OV

VTTI Naturalistic Research

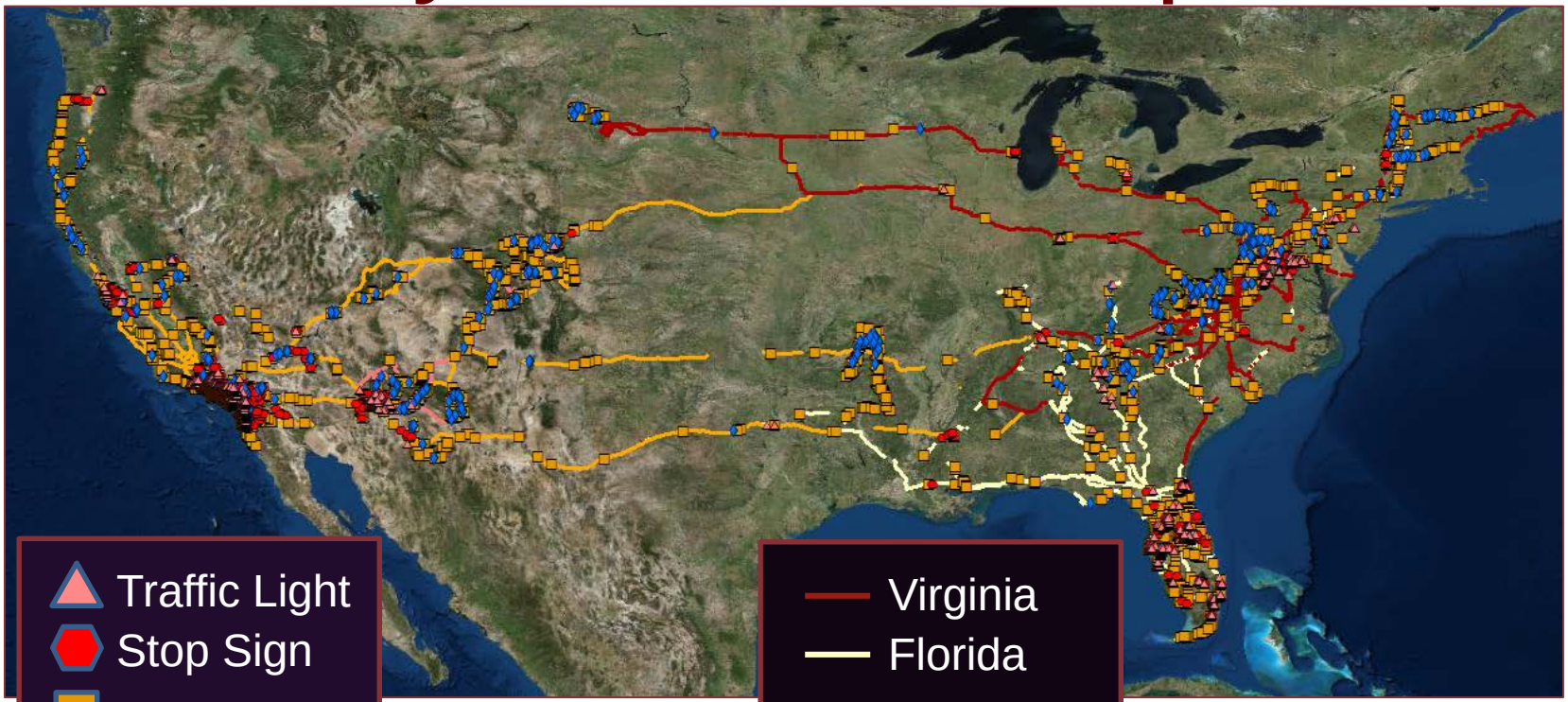
- What if we could watch
  - hundreds of riders of different types?
  - thousands of hours of riding?
- What if we could look in detail at
  - Crashes and close calls?
  - Intersections
  - Curves
  - Traffic


MSF
MOTORCYCLE
SAFETY FOUNDATION
SM
100
Irvine, CA
Blacksburg, VA
Phoenix, AZ
Orlando, FL


NHTSA
www.nhtsa.gov
160
Southern CA


Speed
Radar
Road
Acceleration
Forward Radar
Turn signals
Front Brake
RPM
Lane Position
Rear Brake
Video: Forward
Map
Video: Left
Video: Face
Video: Right
Video: Rear
Legend
vtti.speed_gps 17.38672 for 0 ms
vtti.accel_x 0.0435 for 47 ms
Motohead.External_Status Ignition, Lights
Motohead.RPM 2113 for 60 ms
Road Scout.Lane_Offset 236.219879 for 6 ms
Step Size: 1 Frame
Play Speed: 1.0x
Current Play Location
Current Time: 107951 of 137718ms

Motorcycle Data + Map Data



VTTI Naturalistic: Results from the MSF 100 Motorcyclists Naturalistic Riding Study

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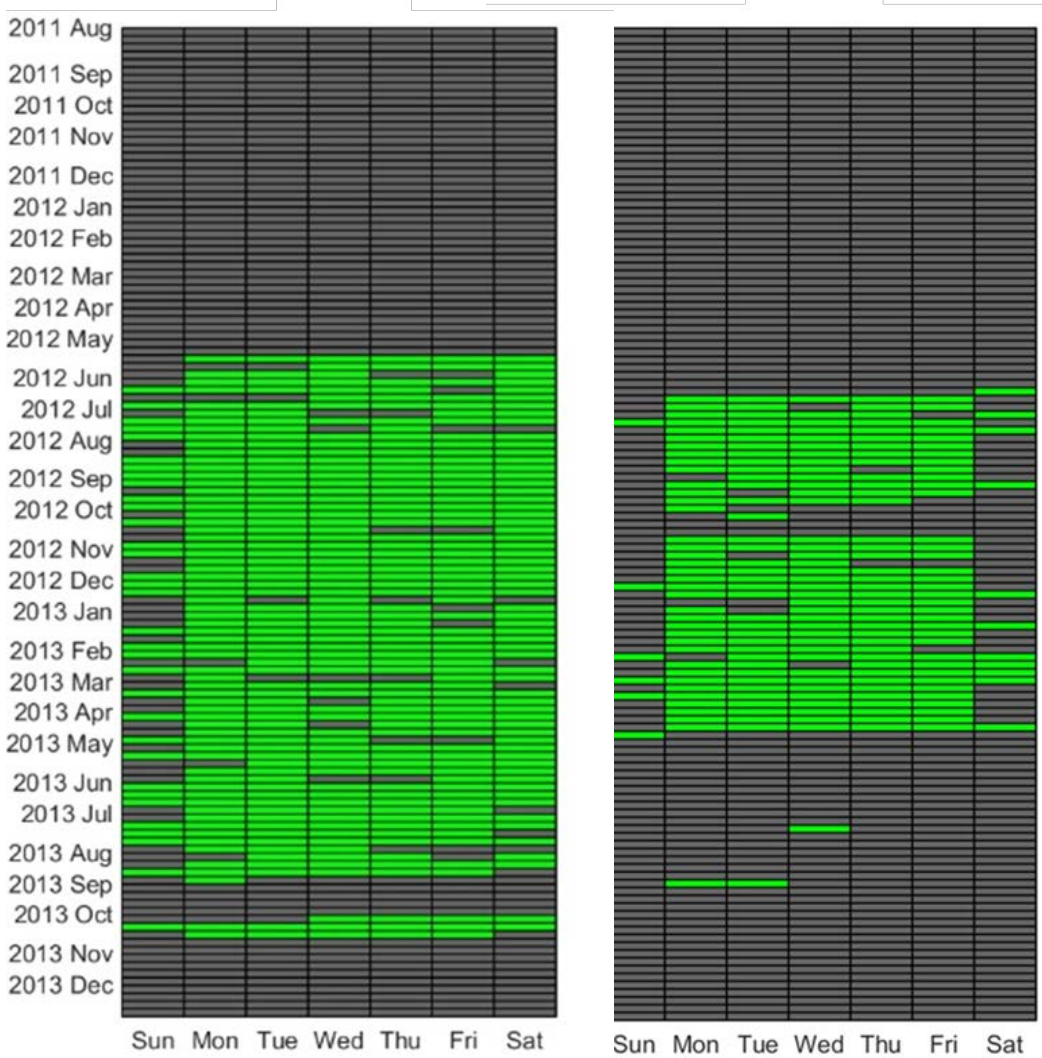
Accelerations and Decelerations

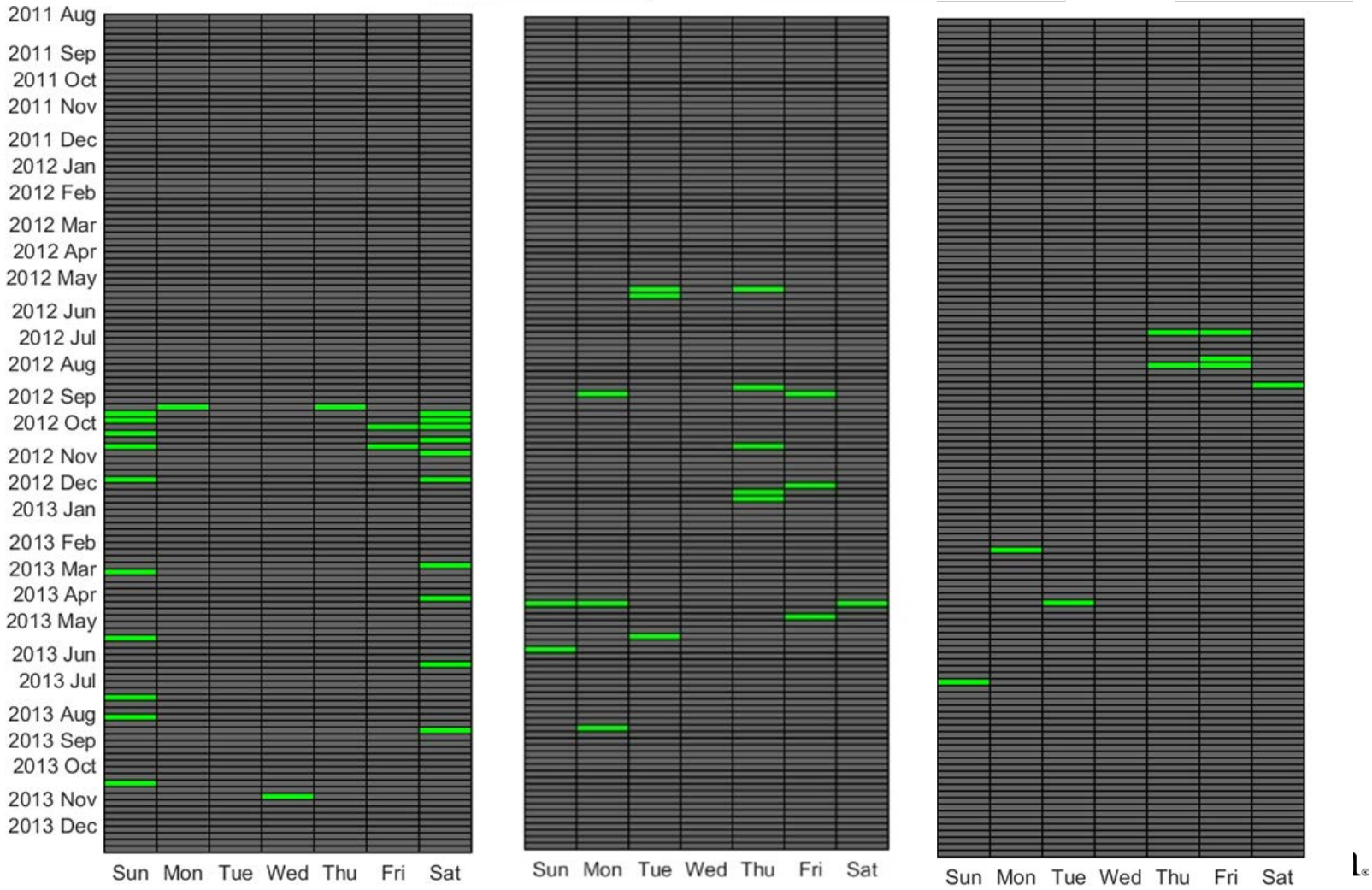
- Riders Accelerate harder than they Decelerate
- The ability to comfortably brake harder comes with increased experience
- You are only as proficient as your practice allows

Proficiency and Experience

- How often do you need to ride to be a motorcycle rider?



Calendar of riding days for different riders


2011 Aug
2011 Sep
2011 Oct
2011 Nov
2011 Dec
2012 Jan
2012 Feb
2012 Mar
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2012 Nov
2012 Dec
2013 Jan
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2013 Apr
2013 May
2013 Jun
2013 Jul
2013 Aug
2013 Sep
2013 Oct
2013 Nov
2013 Dec
Sun Mon Tue Wed Thu Fri Sat
Sun Mon Tue Wed Thu Fri Sat
Sun Mon Tue Wed Thu Fri Sat

Proficiency/Humility

- Lower annual miles - Overall lower level of proficiency
- Gaps in riding - Loss of proficiency (motor skills, judgment)
- There is a **wide range of proficiency in common riding tasks**.
- Very few people are proficient in the 2.5 seconds before a crash.
- **All riders are unskilled at extreme maneuvers.**

Factors that Increase Crash Risk

Variable	Level	Odds Ratio	Reference
	Exposure to this	*increases risk by this many times*	*compared to:*
Intersection Influence	Yes, Uncontrolled	40.7	None
Intersection Influence	Yes, Parking lot, driveway entrance/exit	8.5	None
Intersection Influence	Yes, Traffic signal	2.9	None
Rider Behavior	Aggressive riding (only)	17.9	None
Rider Behavior	Lack of knowledge or skill/Inattention (only)	9.3	None
Rider Behavior	Combination of behaviors	30.4	None
Pre-incident Maneuver	Maneuvering to avoid object	11.8	Going straight, constant speed
Surface Type	Gravel/Dirt road	9.4	Paved, smooth
Roadway Grade	Grade down	4.3	Level
Roadway Grade	Grade up	1.9	Level
Traffic Density	Unstable	3.6	Stable
Roadway Alignment	Curve right	2.1	Straight

Other Vehicles

- Don’t count on them to do what you expect.
- They can brake and turn harder than you.
- At intersections, even when your light turns green, look both ways.

Dangerous Places-Intersections

- Uncontrolled Intersections are the most dangerous place for a rider to be
- Parking lot and driveway entrances are dangerous, as other drivers probably aren’t looking for you.
- Unstable traffic increases crash risk

Single Vehicle Conflicts

- There is a design speed for curves and intersections.
  - If you exceed it…
    - Riders 3x more likely to crash in a curve than straight section of road
    - Right hand curves more problematic than left hand curves
- Riders capsize during low speed maneuvers (u-turns, right turns, starting and stopping)

Rider

- Two biggest crash types
  - Single vehicle
  - Rear-ending someone (very little time to meet or exceed the deceleration of a lead-vehicle)
- Be honest with yourself about your proficiency.
  - Are you a professional athlete?
  - Are you practiced?
    - Don’t substitute how much you love to ride with how much you actually ride.
    - When was the last time you had to brake hard or swerve.

Advice to the Rider

- Practice low speed maneuvers\Parking lots have value
  - Dropping the motorcycle is embarrassing
  - Bike is more unstable at lower speeds
  - Practicing for potential conflicts at low speeds may help when the stakes are higher

Advice to the Rider

- Group rides
  - Don’t assume that the speed or line they choose will be possible for them or you.
    - Riders are 15x more likely to crash in a curve with a group than solo
- Recognize when you have a lot going on in your life or in the life of those around you.
  - Extra workload, long hours
  - Family stress
  - You’re in a hurry.

Thoughts for Non-Riders

- The majority of car crashes are caused by the car driver.
- Make comparisons carefully. Bikes are different than cars (no crumple zone, they fall down)
  - 35% of fatal motorcycle crashes are speeding compared to 22% for cars.
  - Is this apples to apples?
  - Does it mean that more motorcyclists speed?
- Most riders don't like pain and death
- Trying to categorize riders by bike type or brand isn't productive.
- There is some research that indicates that motorcyclists are better drivers than their non-riding counterparts.

Thoughts/Questions?

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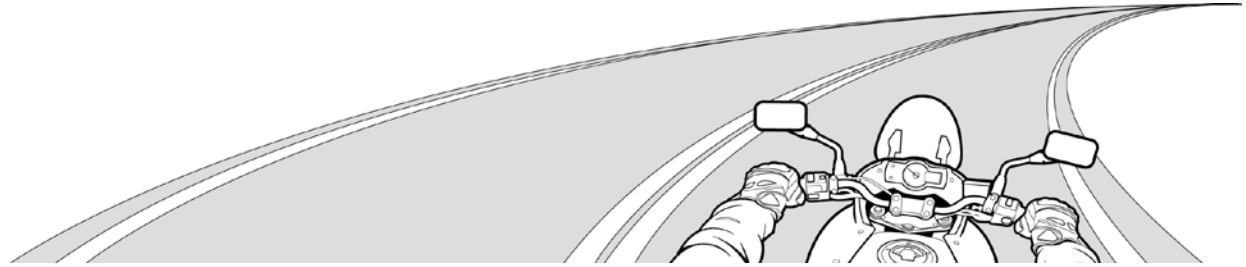

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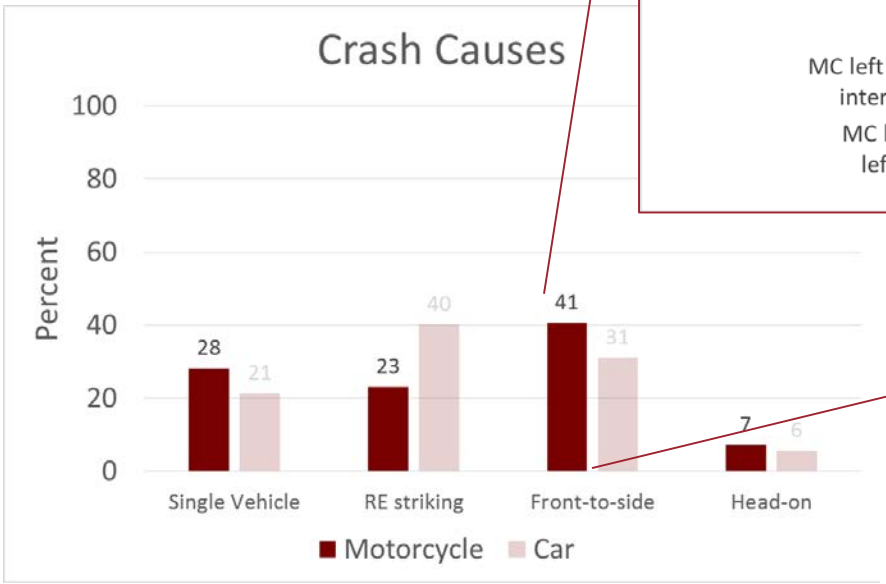
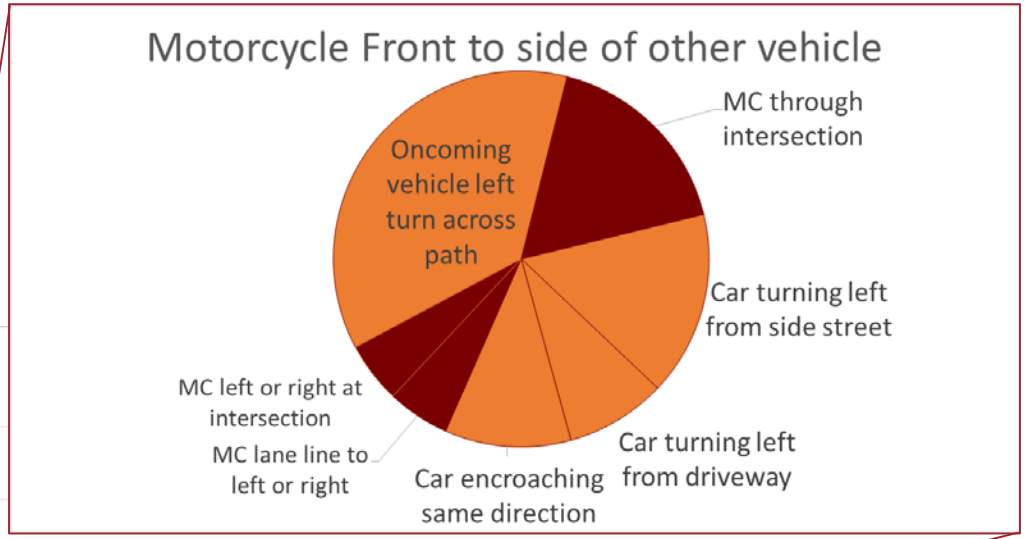
Digging Into Statistics





Decelerations/Accelerations

- Collected ~574,000 decelerations
  - 95th percentile **decelerations** per participant were between **-0.30 g and -0.36 g**.
- Collected ~556,000 accelerations
  - 95th percentile **accelerations** per participant were between **0.38 g and 0.45 g**.
- Not very strong braking.

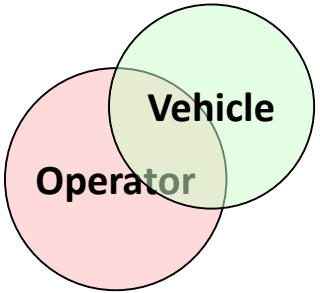
Motorcycle Data + Map Data

Outline

- The on-road situation (environment and physics)
- Death and injury (statistics)
- Our motorcycle research
- Some findings
- Some guidance
- Some thoughts for non-riders

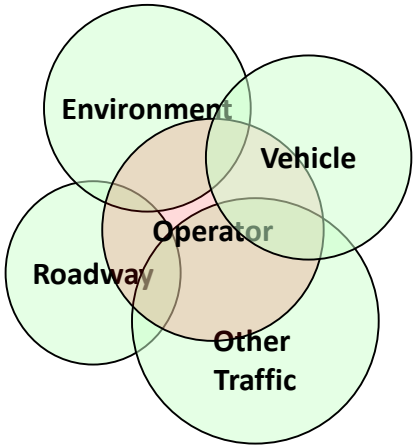
Human Factors

- Human and machine interaction
- Tasks involved
- Human capabilities and limitations related to the activities
- How can the machine or task be optimized for the human?



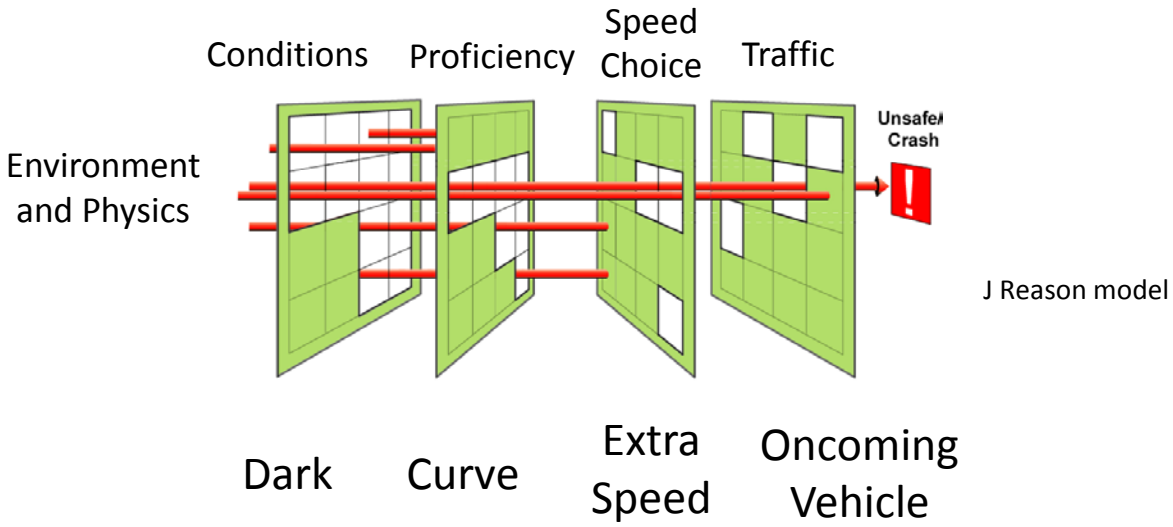
Systems Approach

- Entire system.
- Interactions between components.
- Study the sequence of events
- Look for opportunities within the system to block bad outcomes.



Layers of Protection

- Gun safety
  - Don't have a round in the chamber
  - Keep the gun pointed in a safe direction
  - Keep your finger off the trigger



J Reason model

Performance and Behavior

- Performance – what we're able to do.
  - Reaction time, perception, speed of movements, balance, coordination
- Behaviors – what we choose to do
  - Ride/no ride choice, speed selection, following distance

Example from second most common crash type

Brake Response Time

Response time consists of perception to start of foot movement (0.4s), changing pedals (0.2s), pressing brake pedal (0.1s), plus judgment time during braking.

Kobayashi, 1988 – Human Factors in Driving

Response times for braking fall between 1.5s and 4.0s.

Evans, 1991 – Traffic Safety and the Driver

Response to Events in Roadway

Unexpected

Pedestrians, road debris, or other obstacles may provide little or no time for driver response.

Other Vehicles

Following time is the time available for a driver to match or exceed the deceleration of a lead vehicle.

“For all speeds greater than 55mph, the aggregated most-likely value of [following time] for all of the drivers is 0.8s.”

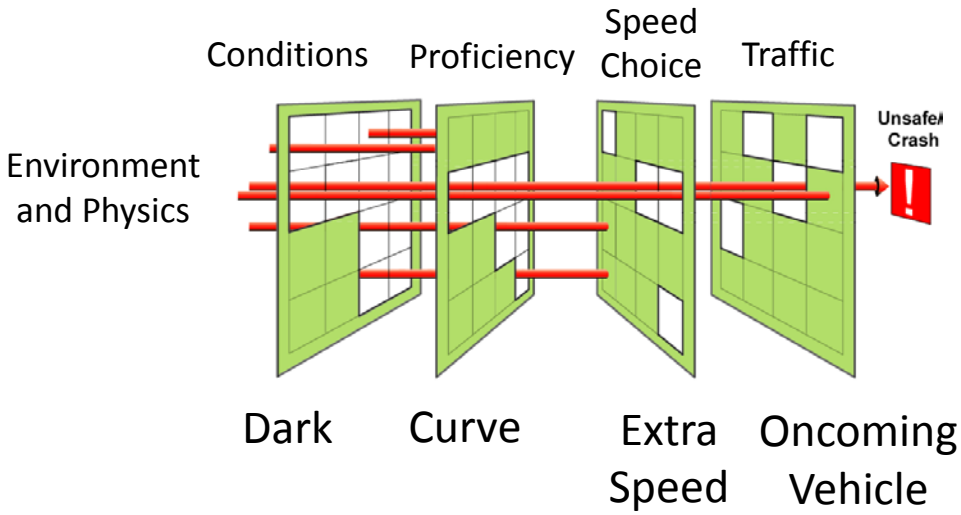
P. Fancher et al, UMTRI, 1998 – Intelligent Cruise Control Field Operational Test

Death and Injury

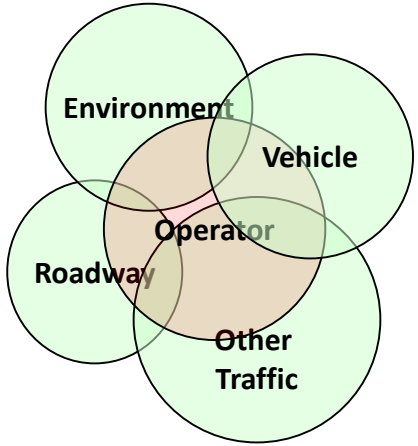
Some Guidance

- Performance – What we can do
- Behaviors – What we choose to do

What layers/countermeasures/defenses will you keep in place?



J Reason model



Environment and Physics (The Situation)

- Threats mostly from forward of the bike, but lots of different ones.
  - One of the biggest threats is the person operating the bike.
- Unstable vehicle
- Not much time available to respond

Discussion

- [x] Alcohol
- [x] Helmets/PPE
- [x] Other impairment
- [ ] The other guy
- [ ] Speed
- [ ] Life events
- [ ] He wasn't as good as he thought he was. Or she.

Motorcycle

- No crumple zone.
- It wants to fall down.
- It is harder to see than a car or truck.
- It is better at accelerating than you are at braking.