Evaluating Road Departure Crashes Using Naturalistic Driving Study Data

Strategic Highway Research Program 2

Transportation Research Board

Third Safety Research Symposium

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Research Team: The Center for Transportation Research and Education (CTRE) at Iowa State University and the University of Iowa

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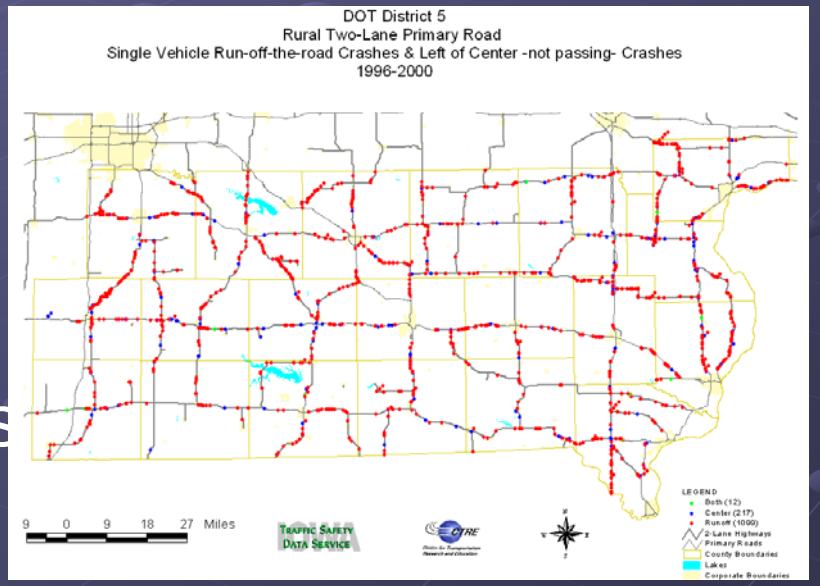
Scope of the problem

- Nationally, SVROR account for 28.9% of fatalities (Neumann et al, 2003)
- 52% of Iowa's fatalities are related to lane departure
- 39% of Iowa's fatal crashes are single-vehicle ROR crashes



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Research Objectives

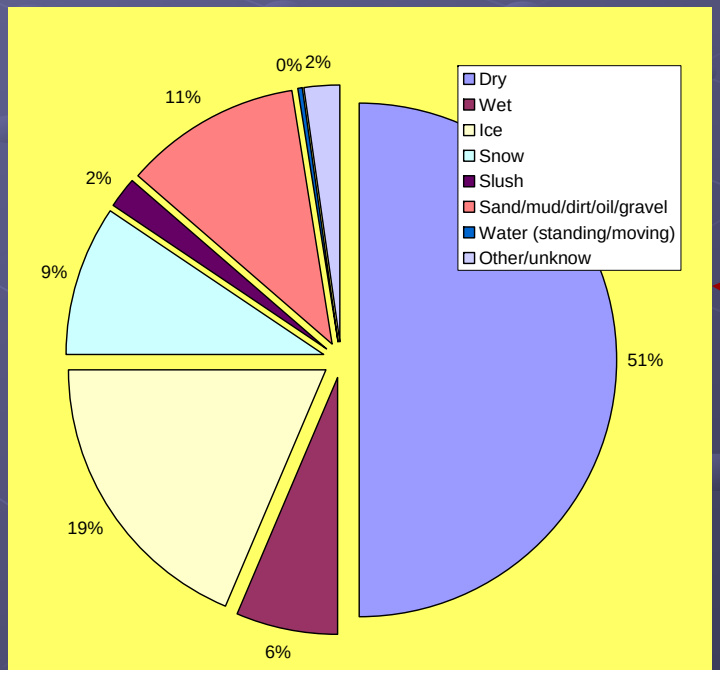
- Analyze ROR crashes using data from existing naturalistic driving studies and other sources
- Develop analytical tools for use in full scale in-vehicle driving study to answer research questions related to road departure
- Provide feedback to improve full scale naturalistic driving study data collection and analysis and mobile mapping data collection so that road departures can be fully addressed

Datasets

- VTTI 100-Car Naturalistic Study
  - Virginia road database
  - Virginia crash database
  - Aerial imagery
- UMTRI Field Tests
  - Michigan road database
  - Michigan crash database
  - Aerial imagery
- University of Iowa Naturalistic Study of Teenage Drivers
- Iowa DOT Crash Database
- Iowa DOT Geographic Information Management System (GIMS) Roadway Database
- FARS

8 Research Questions (Summarized)

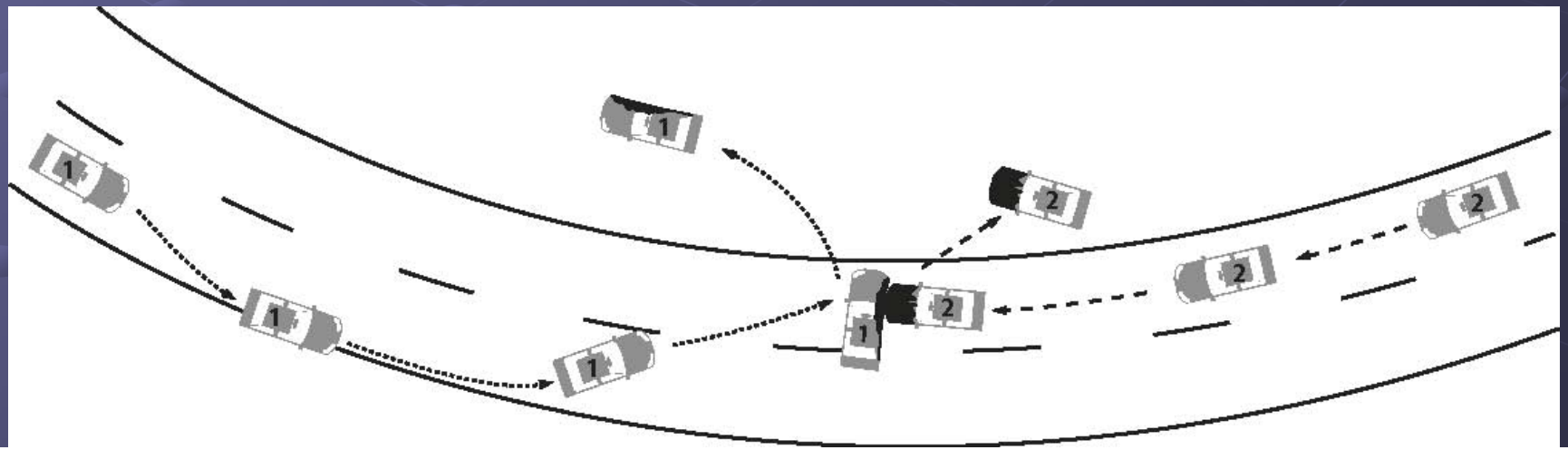
- Evaluate and quantify relationship between driver behavior, roadway, environmental, and vehicle factors for pre- and post-road departures
  - What roadway, environmental, driver, and vehicle factors lead to road departures

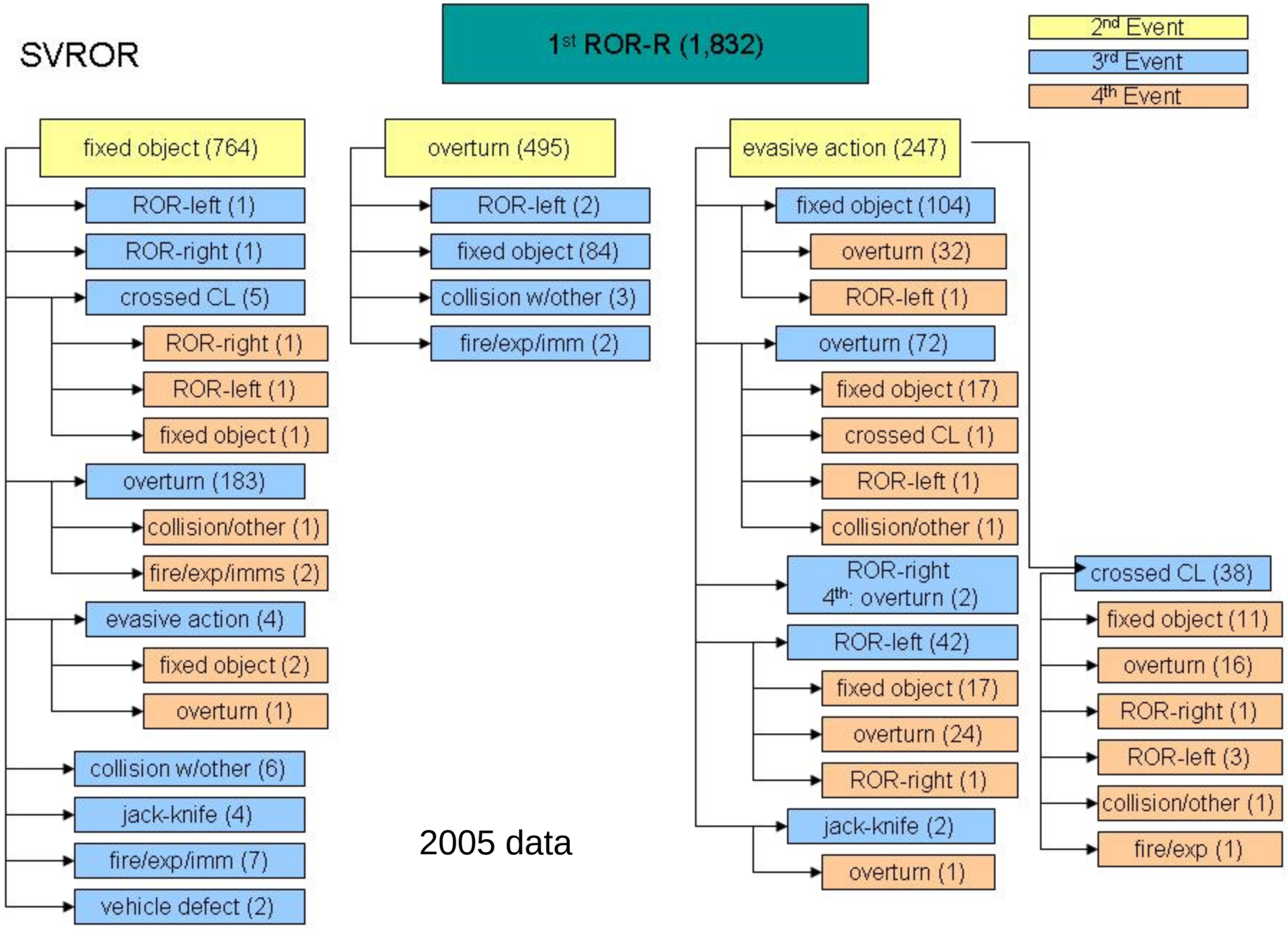


Rural single vehicle run-off-road crashes in Iowa by pavement surface condition (2005 crash data)

Summarized Research Questions

- Once a vehicle initially leaves the roadway how do roadway, environmental, vehicle, and driver factors influence subsequent events and outcomes after a vehicle initially leaves the roadway
- What factors led to positive rather than negative outcomes



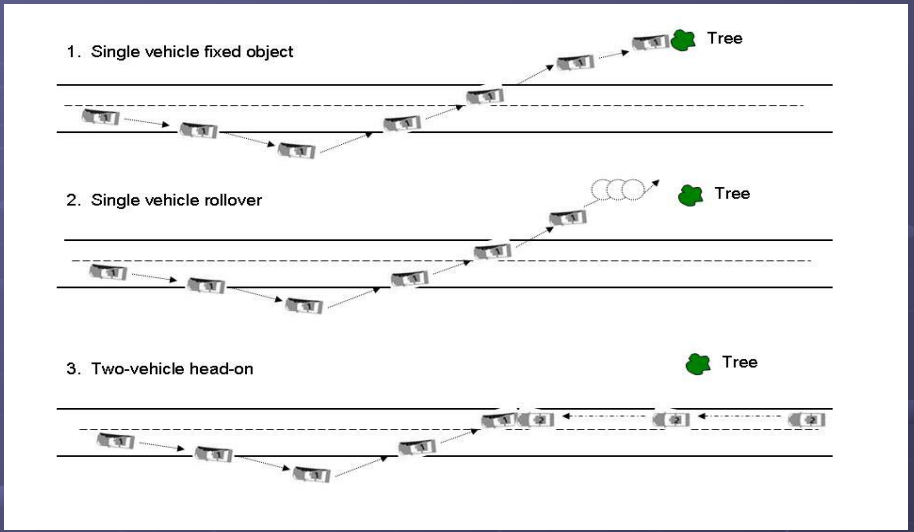

SVROR
1st ROR-R (1,832)
2nd Event
3rd Event
4th Event
fixed object (764)
ROR-left (1)
ROR-right (1)
crossed CL (5)
ROR-right (1)
ROR-left (1)
fixed object (1)
overturn (183)
collision/other (1)
fire/exp/imms (2)
evasive action (4)
fixed object (2)
overturn (1)
collision w/other (6)
jack-knife (4)
fire/exp/imm (7)
vehicle defect (2)
overturn (495)
ROR-left (2)
fixed object (84)
collision w/other (3)
fire/exp/imm (2)
evasive action (247)
fixed object (104)
overturn (32)
ROR-left (1)
overturn (72)
fixed object (17)
crossed CL (1)
ROR-left (1)
collision/other (1)
ROR-right
4th: overturn (2)
ROR-left (42)
fixed object (17)
overturn (24)
ROR-right (1)
jack-knife (2)
overturn (1)
crossed CL (38)
fixed object (11)
overturn (16)
ROR-right (1)
ROR-left (3)
collision/other (1)
fire/exp (1)
2005 data

Summarized Research Questions

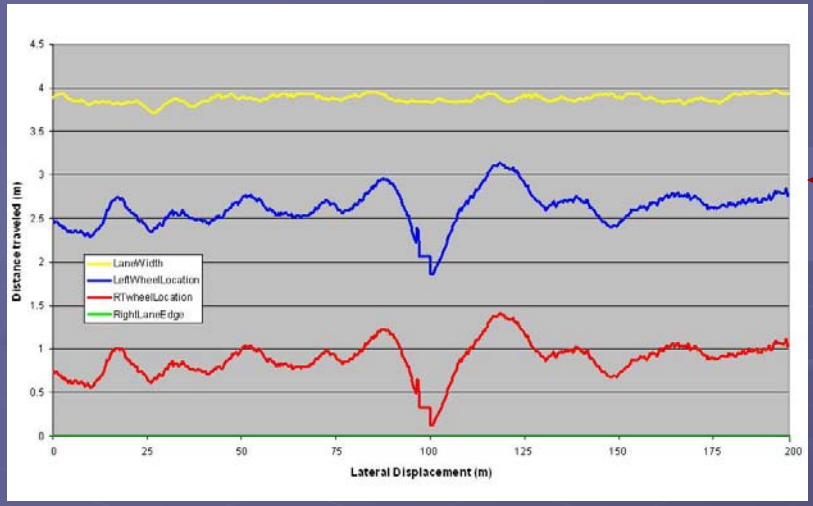
- Can a meaningful relationship between crash surrogates and crashes/near crashes be developed?

Analysis Plan

- Define crash surrogates
  - Non-departure lateral drift
  - Non-conflict road departure
  - Road departure conflict
  - Road departure crash

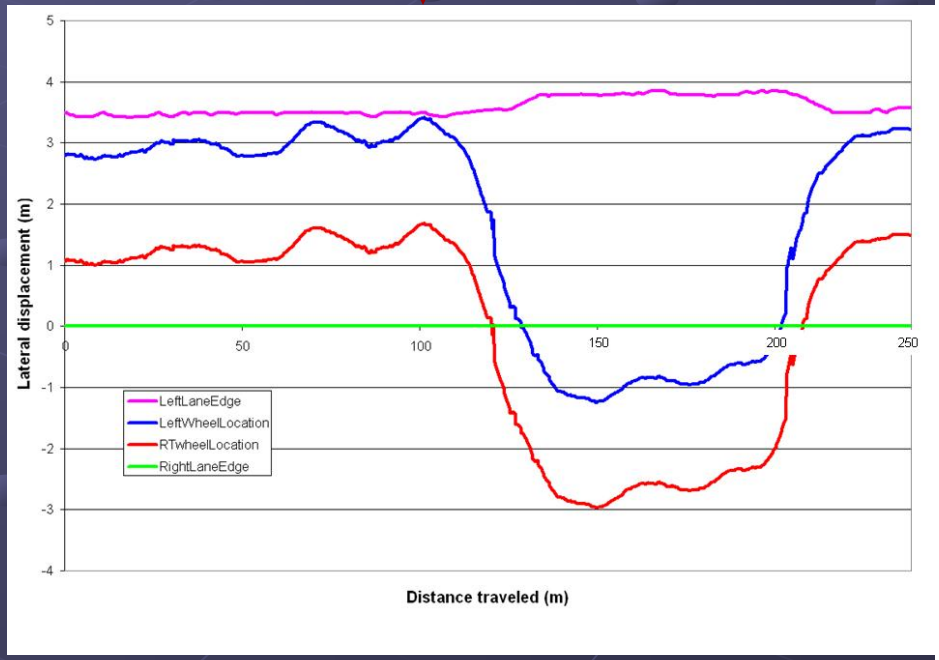


Surrogate depends on potential hazard
Time to collision
Time to lane departure
Time to hazard (on-coming vehicle, adverse slope, fixed object)



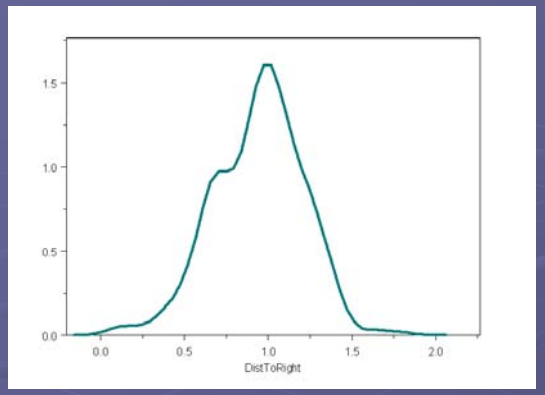
Vehicle trace of non-departure lateral drift (Data source: UMTRI)

Vehicle trace of Non-conflict road departure (Data source: UMTRI)

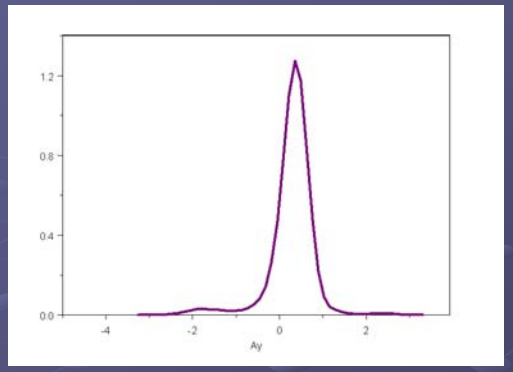


- Define kinematic signatures for each surrogate
  - Lateral acceleration, forward acceleration, speed, brake,
  - Develop algorithm to flag incidents

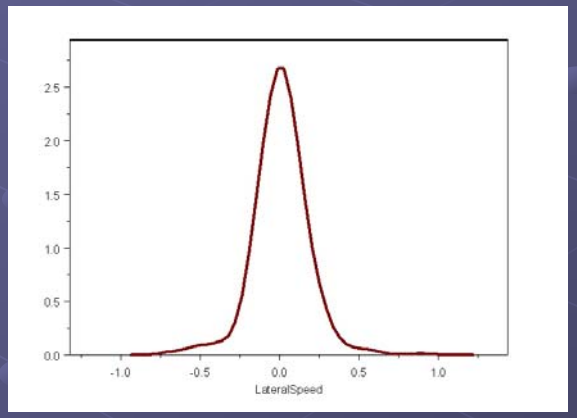
distance to right lane edge (m)



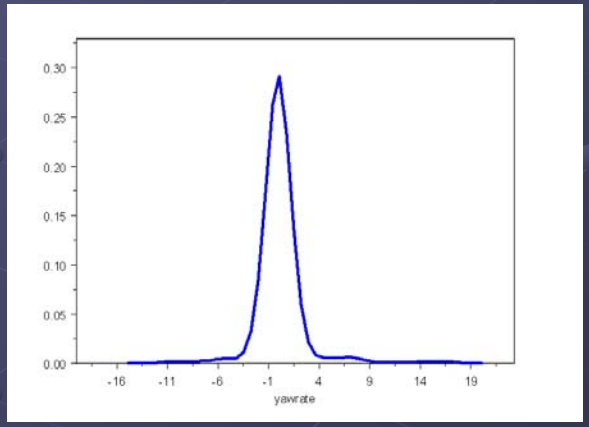
lateral acceleration (m/s²)



lateral speed (m/s);



yaw rate (degrees/second)

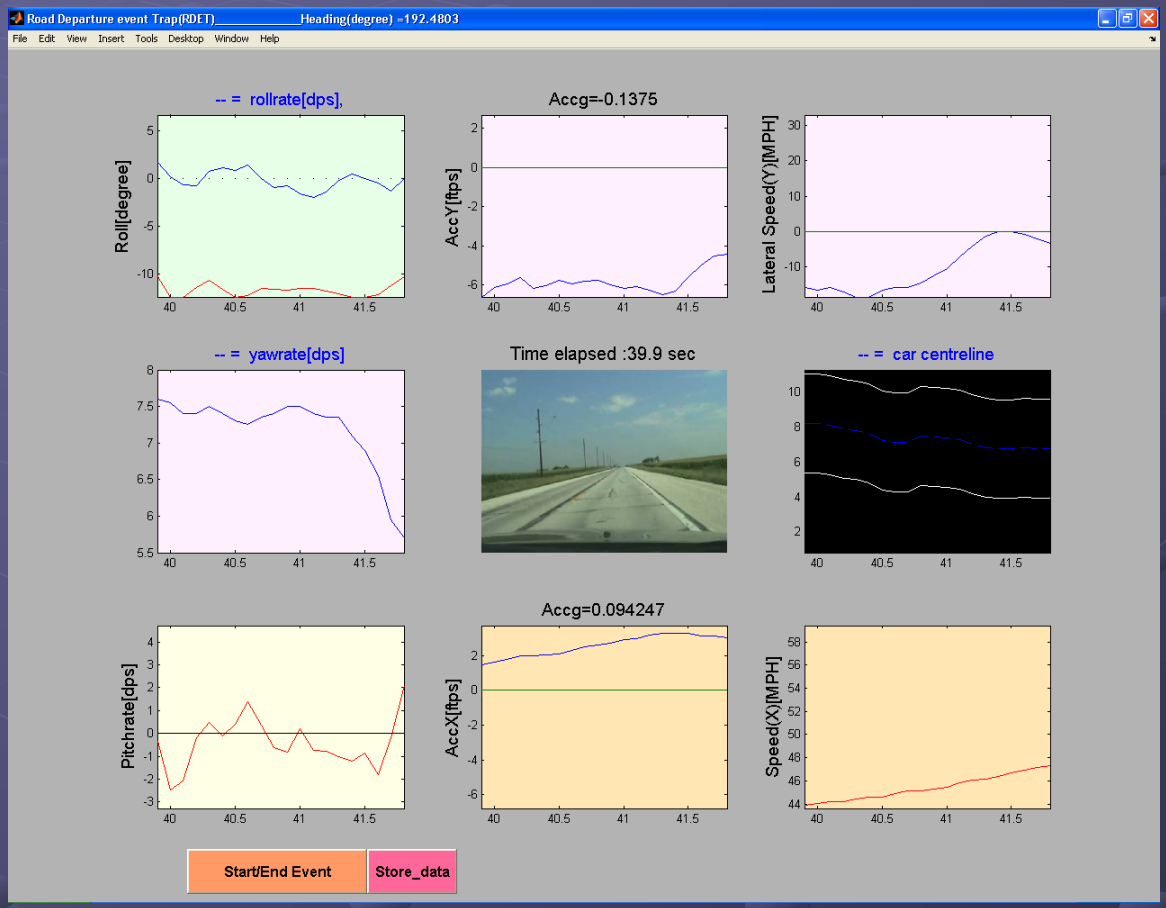


Distribution of Vehicle Activity (Data source: UMTRI)

Select exposure-based risk variables

- AADT
- Driver VMT
- Induced exposure
- Traffic operation from naturalistic driving study data
  - Level of service
  - Headway
  - Traffic density

Develop Analytical Tool to Extract Variables



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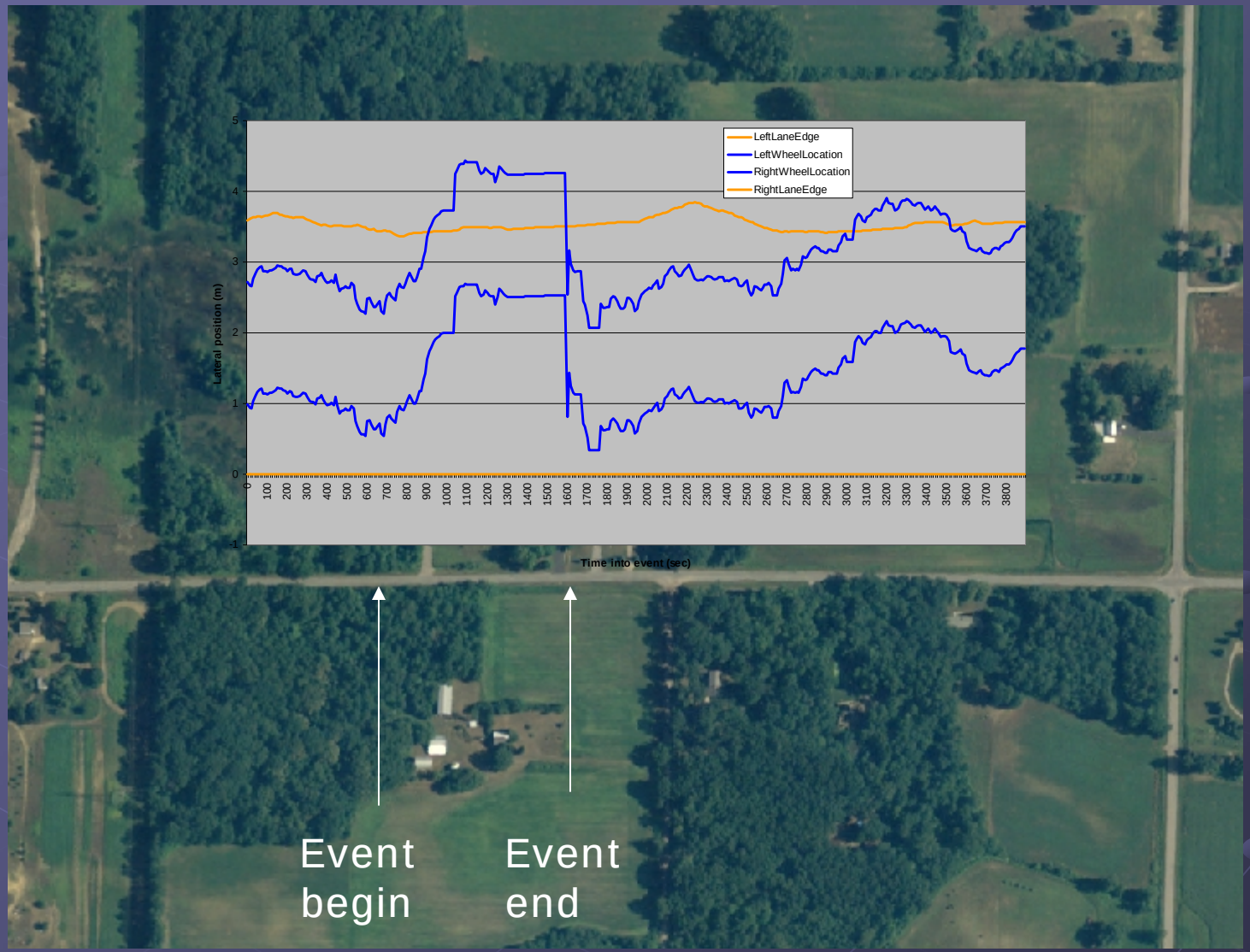
Extract independent variables

- Driver
  - Driver distraction
    - Conversation, grooming, cell phone use, eating, drinking, smoking
    - Time into trip
    - % of time or number of time driver glances away, amount of time or number of times driver engages in non-driving behaviors
  - Aggressiveness
    - % of time driver exceeds speed limit by a certain threshold
    - Number of hard braking or hard acceleration
    - Headway—example: percent time spent following at certain distance
    - Aggressiveness indices
- Environmental
  - Source of information
    - Naturalistic driving study video
    - Meteorological data
  - Potential variables
    - Presence of lighting
    - Roadway surface condition
    - weather

Extract independent variables

- Roadway
  - Source of information
    - Roadway data files
    - Naturalistic driving study video
  - Potential variables
    - Characteristics of horizontal curves (degree of curve, length of curve, etc)
    - Shoulder characteristics (type, width, condition)
    - Roadway cross-section (lane width, type and presence of medians, etc)
    - Pavement markings and signings
    - Rumble strips
    - Sight distance
    - Number of access points


LeftLaneEdge
LeftWheelLocation
RightWheelLocation
RightLaneEdge
Lateral position (m)
Time into event (sec)
Event begin
Event end

Develop statistical models of relationships

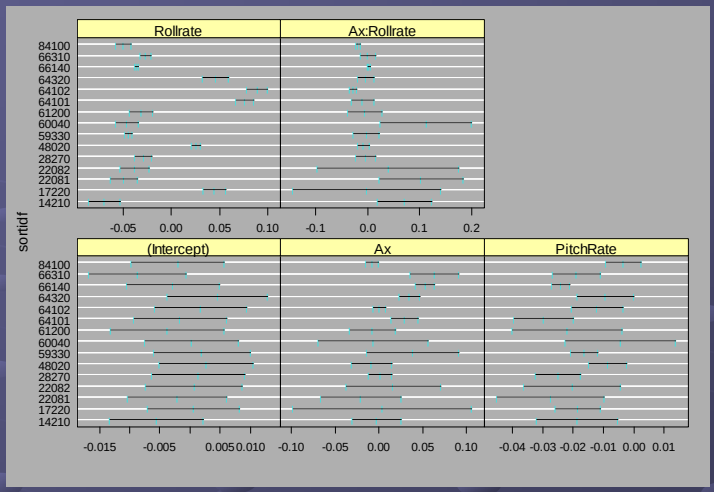
- For each specific research question
  - Determine feasibility of extracting data
  - Determine sample size needed to answer question
  - Address limitations in data
  - Address sample size limitations
  - make recommendations for full-scale in-vehicle field study

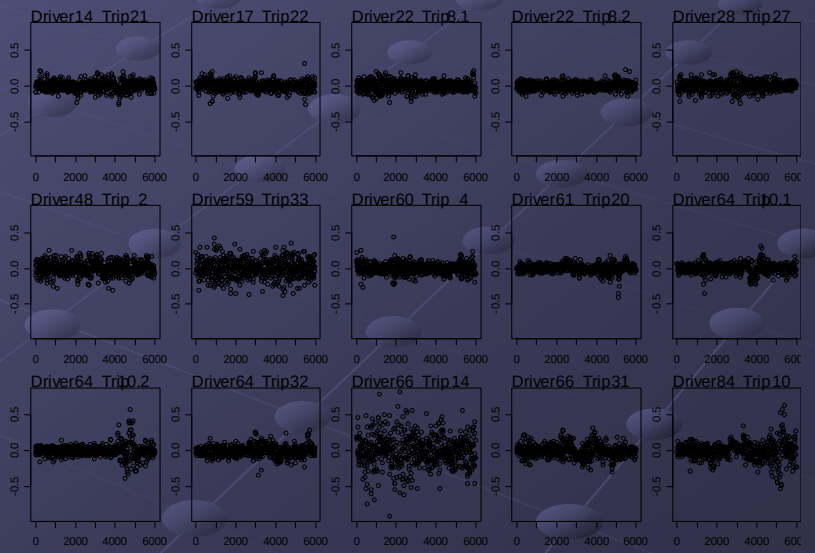
Example: What is the relationship between vehicle speed and safe curve speed (posted/advisory curve speed) and crash risk?

1. How feasible is it to measure curve radius and estimate safe curve speed if posted/advisory speed is not avail be? Other related variables?
2. How many "normal" events are necessary?
3. How many conflict/near-crash/crash events are necessary?

Develop statistical models of relationships

- Statistical model to assess probability associated with each possible category as a function of driver, vehicle, road and environment attributes.
  - Generalized linear model, Bayesian, etc
  - Account for correlations between observations on the same subject
  - Account for confounders that can obscure the effect of a driver, vehicle, road or environmental factor on the probability of an event.
  - Apply model diagnostics





Develop statistical models of relationships

- Develop tools that they can be applied to full-scale

Questions?