The “100 Car” Study: A Pilot for Large-Scale Naturalistic Driving Research

- 241 drivers
- No instructions
- 80/20 own/leased
- 12-13 months
- 43,000 hours
- 2.0 MVMT

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Naturalistic Data Collection Approach

Highly capable instrumentation (well beyond EDRs)

- Five channels of digital, compressed video
- Four radar sensors front, rear (for all 100 cars), and side (for 20 cars)
- Machine vision-based lane tracker
- Many other sensors: GPS, glare, RF, acceleration, yaw rate, controls, etc.
- Cell phone, wireless internet, or hardwire download
- Ties into vehicle networks to obtain other information

Demonstrates the feasibility of the F-SHRP Safety instrumented vehicle approach

100 Car Instrumentation Mounted in Trunk

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Uses of Naturalistic Data

- Detailed crash/near crash causation analysis
  - More pre-crash information than ever before available.
- Safety surrogate validation
  - The relationship between crashes and near crashes
  - The relationship to other surrogates like eye glances, lane departures, and other performance measures
- Model development and validation
  - Crash benefits estimation
  - Crash countermeasure assessment
- Countermeasure modeling example from follow-on project work in progress

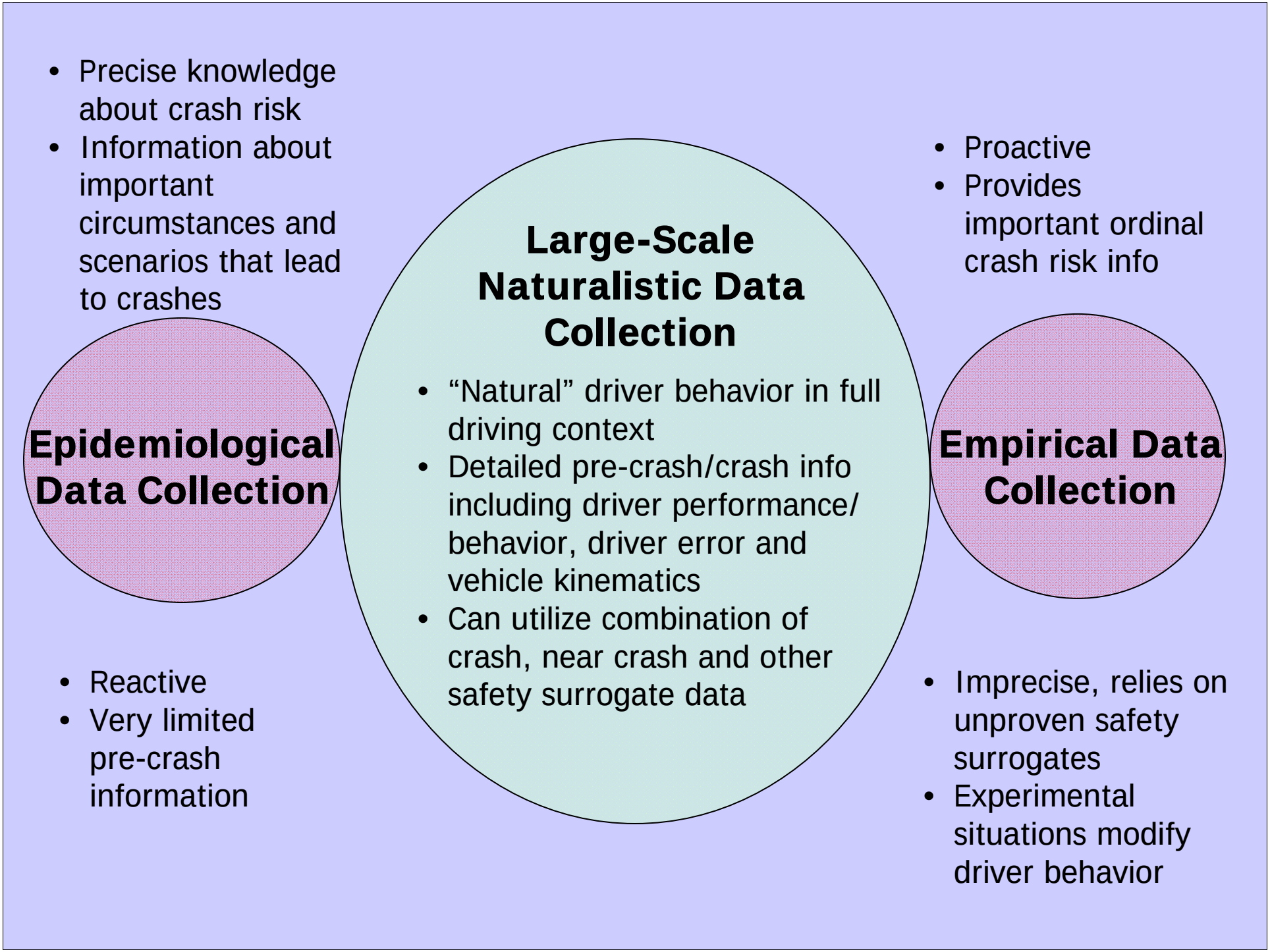
Next generation hardware/software

- Much smaller main unit and radars
  - Board-level
- Automatic reading of multiple-networks
- Machine vision-based sensing
- Greatly improved video compression
- Constantly evolving data reduction tools

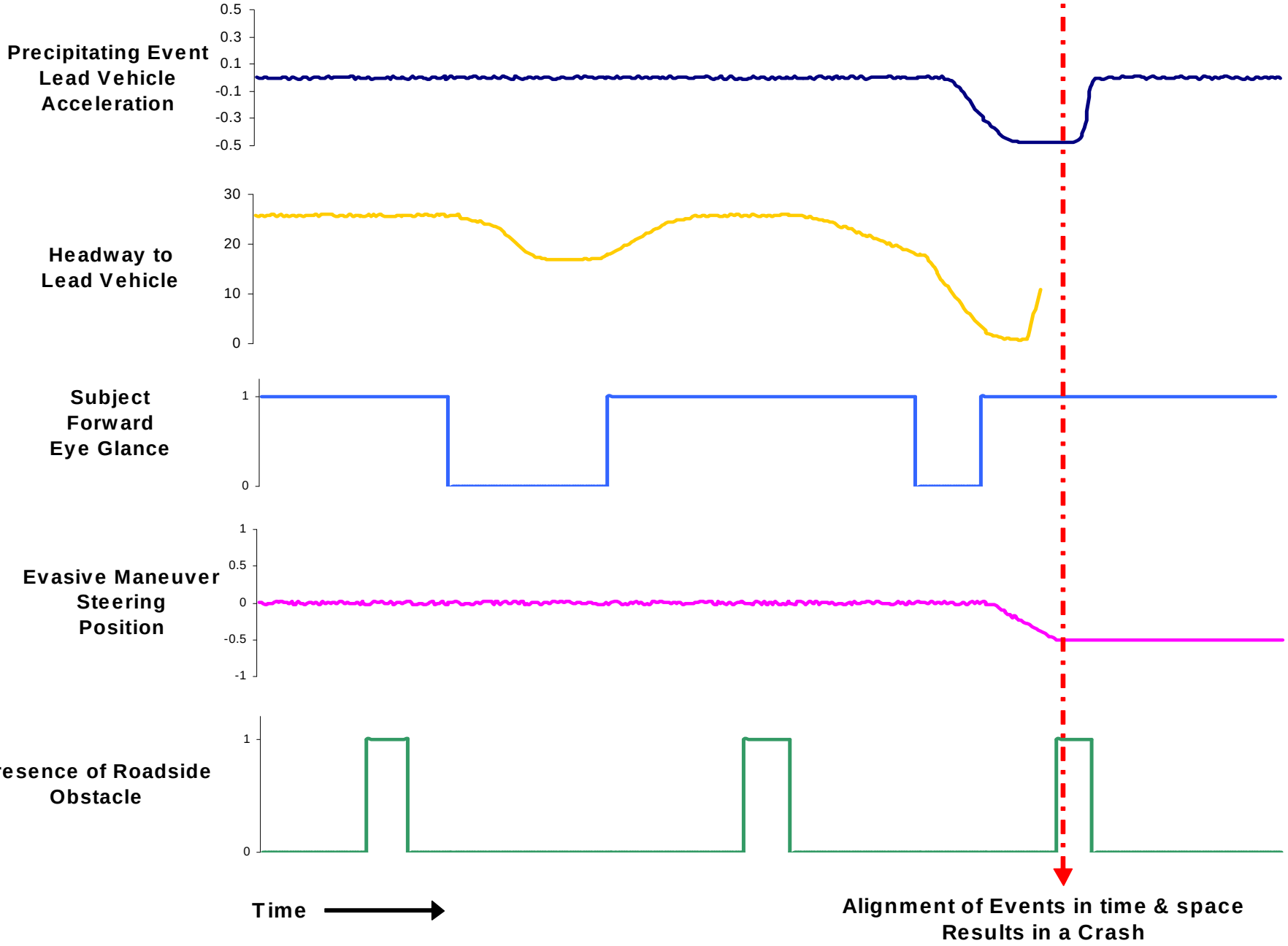
Use of Naturalistic Data for Crash Causation Assessment

- What is the advantage of the “Naturalistic” approach for crash/near crash causation assessment?

- Essentially, while existing tools are indispensable, they have major drawbacks.


Precise knowledge about crash risk
Information about important circumstances and scenarios that lead to crashes
Epidemiological Data Collection
Reactive
Very limited pre-crash information
Large-Scale Naturalistic Data Collection
"Natural" driver behavior in full driving context
Detailed pre-crash/crash info including driver performance/ behavior, driver error and vehicle kinematics
Can utilize combination of crash, near crash and other safety surrogate data
Proactive
Provides important ordinal crash risk info
Empirical Data Collection
Imprecise, relies on unproven safety surrogates
Experimental situations modify driver behavior

Multi-Linear Events Sequence: Pole Crash



Example 100 Car Study Results

The capture of crash/collision events that included minor, non-property-damage contact. Lower severity collisions provide very valuable information and occur much more frequently (i.e., 5 to 1) than more severe crashes. This has important implications for future naturalistic driving studies aimed at assessing driver-related crash causation.

Collision Category 1 (Police-reported and/or contains an airbag or injury)	
Left Turn Against Path	1
Rear-End Struck	2
Run-Off-Road	2
Subtotal	5

Collision Category 2 (Police-reported with property damage only)	
Lane Change	1
Left Turn Against Path	1
Rear-End Struck	2
Rear-End Strike	5
Run-Off-Road	2
Subtotal	11

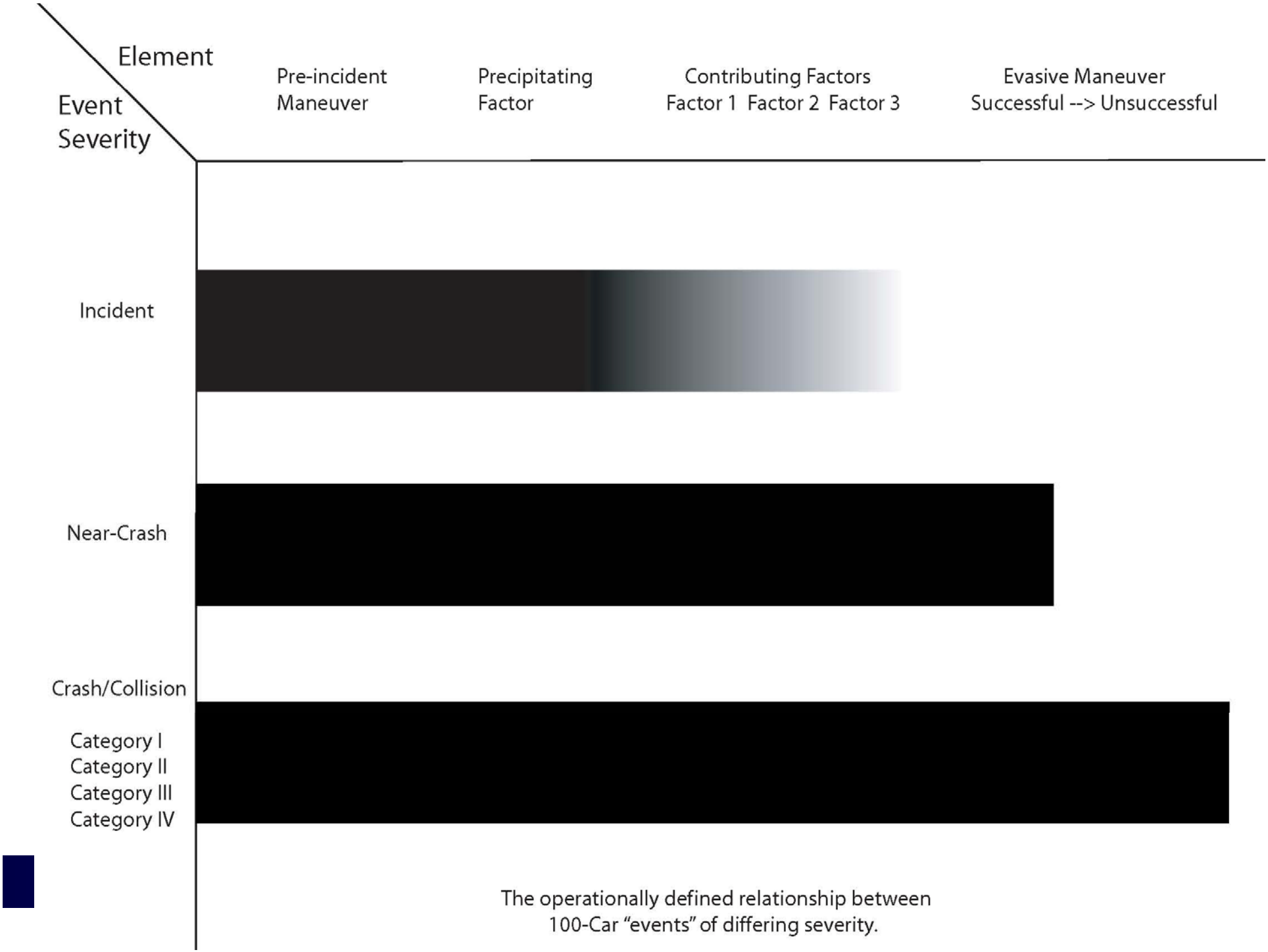
Collision Category 3 (Non-police-reported, physical contact/property damage)	
Backing	2
Object	4
Rear-End Strike	6
Rear-End Struck	6
Run-Off-Road	6
Sideswipe	1
Subtotal	25

Collision Category 4 (Non-police-reported, physical contact/no property damage)	
Animal	2
Backing	8
Object	1
Rear-End Strike	6
Rear-End Struck	4
Run-Off-Road	20
Subtotal	41

Total 82

Example 100 Car Study Results

This study allowed the capture and assessment of near crash events in large numbers. Near crashes provide valuable information as a surrogate for crash events *and* as a tool for the assessment of the factors that contributed to the execution of a successful evasive maneuver.



The operationally defined relationship between 100-Car "events" of differing severity.

Example 100 Car Results: Relative Risk Estimates for Crash/Near Crash Inattention Events

Reaching for moving object Fatigue (moderate to severe) Looking at specific external object (longer glance) Reading Applying makeup Dialing cell phone (manual)	8.3 4.6 3.6 3.2 2.9 2.6	L.C.I. > 1.0	Long eye-off-road time and/or Multi-step/complex manual task.
Eating without utensils Reaching for non-moving object Cell phone talking/listening (hand held) Cognitive – general (e.g., "lost in thought", etc.) Simple radio tasks (volume/pre-set select)	1.5 1.3 1.2 0.8 0.7	C.I. contains 1.0	Shorter glances and/or Simpler tasks and/or Cognitive distraction only.
Driving related glance – left window Passenger in adjacent seat (not looking at passenger) Driving related glance – center mirror	0.5 0.4 0.1	U.C.I. < 1.0	Driver actively engaged in scanning. Safer driving due to passenger presence.

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Preliminary Results from 100-Car Study

Type of Secondary Task	Population Attributable Risk %	Lower CL	Upper CL
Fatigue	**22.2**	**21.7**	**22.7**
Reaching for a moving object	1.1	0.97	1.3
Insect in vehicle	0.4	0.3	0.4
Looking at external object	0.9	0.8	1.1
Reading	**2.9**	**2.6**	**3.1**
Applying make-up	1.4	1.2	1.6
Dialing hand-held device	**3.6**	**3.3**	**3.9**
Inserting/retrieving CD	0.2	0.2	0.3
Eating	2.2	1.9	2.5
Reaching for non-moving object	1.2	1.0	1.5
Talking/listening to hand-held device	**3.6**	**3.1**	**4.1**
Drinking from open container	0.04	-0.1	0.2

Crash Risk Estimate for Inattentive Drivers for Differing LOS

	Type of Traffic Density	Odds Ratio	Lower CI	Upper CI
1.	**LOS A: Free Flow**	0.76	0.62	0.94
2.	**LOS B: Flow with Some Restrictions**	0.92	0.73	1.14
3.	**LOS C: Stable Flow – Maneuverability and Speed are more Restricted**	**2.74**	**2.08**	**3.63**
4.	**LOS D: Flow is Unstable – Vehicles are unable to pass with temporary stoppages**	**4.53**	**2.47**	**8.30**
5.	**LOS E: Unstable Flow- Temporary restrictions, substantially slow drivers**	**4.88**	**3.19**	**7.48**
6.	**LOS F: Forced Traffic Flow Conditions with Low Speeds**	0.82	0.20	3.33

100 Car Study Summary

- The 100 car study demonstrates the feasibility of the naturalistic approach for a large-scale study.
- The resulting data can be used to answer many causation and countermeasure questions.
- The combination of near-crash, detailed pre-crash, lower severity crash, and higher severity crash data make this a very powerful tool.
- Both epidemiological and empirical techniques can be used to conduct risk-based and performance based analyses.

Additional Naturalistic Driving Studies

- Newly licensed teen driver study (40 cars)
- Older driver study (75+)
- Long haul/line haul trucks (46 trucks DDWS FOT + 8 additional trucks)

Lessons to consider

- Growing body of evidence that near-crash is an effective surrogate
- Data reduction effort = Data collection/10
- Goal should be to collect as much raw data as possible
- Exposure is reasonable: 20,000 samples = 3 months
- Data on all types of crashes will be present

Lessons to consider

- Uses of data = *a priori* X 10
- Crashes = police-reported X 4
- Privacy issues are not show stoppers
- What data do you really need to share?