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100-Car Naturalistic Driving Study Fact Sheet

June 10, 2005

The 100-Car Naturalistic Driving Study was recently completed by the Virginia Tech Transportation Institute (VTTI) and sponsored by the National Highway Traffic Safety Administration (NHTSA), Virginia Tech, Virginia Department of Transportation (VDOT), and Virginia Transportation Research Council (VTRC). See the full story.

Setting Up the Study

Study Sponsors:

- Virginia Tech Transportation Institute (VTTI)
- National Highway Traffic Safety Administration (NHTSA)
- Virginia Department of Transportation (VDOT)
- Virginia Transportation Research Council (VTRC)

Study Parameters:

- 109 primary drivers, 241 total drivers (primary plus secondary)
- Northern Virginia/Metropolitan Washington, DC area
- 12 - 13 months of data collection

100-Car Study Features:

- First instrumented-vehicle study undertaken with the primary purpose of collecting pre-crash, naturalistic driving data.
- First study of its kind detailing information on a large number of near-crash events.
- Capture of events that include minor contacts with no property damage.
- Drivers were given no special instructions and no experimenter was present.
- Vehicles were used for daily commutes and general driving.
- Data collection instrumentation was unobtrusive.

Participant Demographics:

- Drivers were recruited from flyers and newspaper ads
- Ages ranging from 18 to 73 years old; 60 percent male; 40 percent female
- Driving histories ranged from very "safe" to very "unsafe" according to number of self-reported accidents
- In addition, participants represented:
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    - A wide range of driving experience levels (number of miles driven)
    - Driving experience on all road types
    - Driving in urban, suburban and a small amount in rural areas

Vehicles (primarily sedans and SUVs):

- Chevrolet Cavalier
- Chevrolet Malibu
- Ford Explorer
- Ford Taurus
- Toyota Camry
- Toyota Corolla

Data Collection Instrumentation Included:

- Five channels of digital, compressed video
- Up to a total of four radar sensors; front, rear (for all 100 cars) and each side (for 20 cars)
- Machine vision-based lane tracker
- Multiple other sensors; GPS, accelerometers, glare, Radio Frequency Detectors
- Cellular telephones, wireless internet, or hardwire downloading equipment

Instrumentation Features:

- Connected to the manufacturer's in-vehicle network to obtain other sensor information
- Ruggedized and crash-tested
- Fault detection system on-board to warn of instrumentation system failures
- Appeared to have minimal effect on driving patterns of participants after first hour of driving

Data Assembly

The Event Database:

- Primary contributions of the 100-Car Study database
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    - Format is similar to epidemiological crash databases, but with video, driver and vehicle data appended
    - Contains many extreme cases of driving behavior and performance, including severe fatigue, impairment, judgment error, risk taking, engagement in secondary tasks, aggressive driving and traffic violations

- Video and electronic data from the database can be replayed multiple times and at varying frame rates in order to fully understand the nature of each event. Events were classified as one of the following:
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    - Crash - any physical contact between the subject vehicle and another vehicle, fixed object, pedestrian, pedacyclist or animal
    - Near-Crash - situations requiring a rapid, severe evasive maneuver to avoid a crash
    - Incident - situations requiring an evasive maneuver occurring at less magnitude than a near-crash
- Once events were identified, a battery of variables were recorded by trained data reductionists including, such things as:
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    - Pre-event maneuver
    - Precipitating factor
    - Contributing factor
    - Associative factor
    - Avoidance maneuver

Data Gathered

Miles Driven:

- 0 - 9,000; 29 drivers; 26.6 percent of all participants
- 9,001 - 12,000; 22 drivers; 20.2 percent of all participants
- 12,001 - 15,000; 26 drivers; 23.9 percent of all participants
- 15,001 - 18,000; 11 drivers; 10.1 percent of all participants
- 18,001 - 21,000; 8 drivers; 7.3 percent of all participants
- More than 21,000; 13 drivers; 11.9 percent of all participants

Crashes, Near-Crashes and Incidents Recorded:

- Approximately 2,000,000 vehicle miles of driving
- 42,300 hours of driving data
- 15 police-reported and 67 non-police-reported crashes which included low "g" events such as struck or ran over curbs and parking blocks (some vehicles involved in multiple crashes)
- 761 near-crashes
- 8,295 incidents

Other Driving Events Recorded:

- Impairment
- Traffic violations
- Aggressive driving and "road rage"
- Seat belt usage

Discoveries

Driver Inattention:

- Nearly 80 percent of all crashes and 65 percent of all near-crashes involved driver inattention just prior to (i.e., within 3 seconds) the onset of the conflict. Prior estimates related to driver inattention as a contributing factor have been in the range of 25 percent of all crashes.
- Inattention was a contributing factor for 93 percent of rear-end-striking crashes.

Rear-End-Striking Crashes:

- In 86 percent of rear-end-striking crashes, the headway at the onset of the event was greater than 2.0 s.
- The most frequent cases of low-severity conflicts (i.e., incidents and near-crashes) involving conflict with a lead vehicle occurred in lead-vehicle moving scenarios, while 100% of the crashes (14 total) occurred when the lead vehicle was stopped. This indicated that drivers have sufficient awareness and ability to perform evasive maneuvers when closing rates are lower and/or expectancies about the flow of traffic are not violated.

Age-Related:

- Judgment error, including secondary task performance in higher risk situations, driving while impaired, and other instances of aggressive driving, was much more prevalent in the youngest age group (i.e., 18 to 20 years) relative to the older age groups.
- The rate of inattention-related crash and near-crash events decreased dramatically with age, with the rate being as much as four times higher for the 18- to 20-year-old age group relative to some of the older driver groups (i.e., 35+ years).

Hand-Held Wireless Devices:

- Primarily cellular telephones, but including a small amount of PDA use
- Associated with the highest frequency of secondary task distraction-related events for both incidents and near-crashes
- Among the highest frequencies for crashes along with object-in-vehicle and passenger-related secondary tasks

Fatigue:

- Contributing factor in 12 percent of all crashes and 10 percent of all near-crashes, while most current database estimates place fatigue-related crashes at approximately 2 to 4 percent of total crashes.

Considerations and Conclusions

Study Limitations:

- Age groups missing (16 to 17 and 75+ years)
- Participants drove in only one area (Northern Virginia/Metropolitan Washington, DC)
- Relatively little rural driving

- Fewer SUVs and light trucks than the national average

Advantages of the 100-Car Study's Naturalistic Research Approach:

- Naturalistic driving research can "fill in the gaps" from existing driving safety research methods.
- Both video and electronic sensor data provide much greater information regarding the pre-crash and crash events than is currently available in crash databases, even those containing detailed crash investigation variables.
- Drivers often do not remember specific details of a rapidly-occurring event. However, naturalistic studies overcome the obstacle of potentially unreliable eyewitness crash accounts. For example, eyewitness accounts could include a driver or passenger who is in shock or injured or someone who is trying to hide the details of what occurred (due either to embarrassment, fear of prosecution/litigation, or other reasons).
- The 100-Car Study provided much more realistic driving data than data previously obtained on test tracks or in simulators, in that drivers possessed self-induced time pressures and motivations.

Advantages of studying near-crashes and non-police-reported crashes in addition to crash events:

- Near-crashes occurred 15 times more frequently than crashes.
- Every near-crash and incident demonstrated a driver successfully performing an evasive maneuver.
- Details of successful evasive maneuvers may provide additional insight into effective defensive driving techniques and factors, as well as insight into potential countermeasures for these driving situations.
- Data from non-police-reported crashes may provide valuable information to help better understand crash causation, as these crashes occurred much more frequently than police-reported crashes. For urban/suburban settings, this suggests that total crash involvement may be over five times higher than police-reported crash involvement.

Database Availability:

- The initial event database will be made publicly accessible via the internet in limited form, i.e. no video will be present to protect the anonymity of the participants.
- In addition, the initial event database can be continually enhanced, since all of the video and electronic data for the entire study have been archived.

Future Uses of the 100-Car Study's Database:

- Detailed crash/near-crash causation analysis with more pre-crash information than ever before available
- Potential for future studies aimed at assessing driver-related crash causation
- Assist in the establishment of a statistical relationship between incidents, near crashes, and crashes will help to better understand crash causation without conducting large-scale research efforts
- Crash countermeasure algorithm development