Determining the Causes of Motor Vehicle Crashes
“Accountability” Rather Than “Causation” in Large Truck Crashes

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The Large Truck Crash Causation Study (LTCCS) and the National Motor Vehicle Crash Causation Study (NMVCCS) used the same methodology to examine over 6,000 fatal and serious injury crashes. For every crash a large amount of data was collected through written crash reports, vehicle inspections, and personal interviews. Conducting thorough crash investigations like those in these studies is impossible for every major crash. However, a test conducted with a large sample of the LTCCS crashes found that coding only from the crash police accident reports (PARS) resulted in the same conclusion on important crash elements in a large majority of the cases. This paper will examine the test results and its implications for identifying potential unsafe commercial motor carriers.

What is “Cause”?

A car runs off the road in the middle of a sharp curve on a snowy day and hits a tree resulting in complete destruction of the vehicle and death of the driver. Was the roadway curve poorly designed, the road surface slippery, the brakes in poor condition, the driver not in condition to operate a motor vehicle, the driver distracted, or some other factor? Any of these could have contributed to the crash. Some crash related factors are present only at the time of the crash, but many extend back in time before the crash. A slippery road surface may have resulted from a snow storm right before the crash or the build-up of snow in previous days, but the design of the highway was at least months before. The driver at the time of the crash might have made an error by diverting his attention from the road to change the radio station, discard an apple core, or adjust the rearview mirror. Or the driver could have been intoxicated from consuming alcohol an hour before the crash and thus not able to successfully drive a vehicle in adverse conditions even while focusing correctly at the time of the crash.

The most complete examination of vehicle crashes in the United States is conducted by the National Transportation Safety Board when a commercial airliner goes down. Millions of dollars and hundreds of hours are expended to explain each crash, but no single cause is ever determined. Major contributing factors and probable contributing factors are reported, but no cause is reported.

Cause in the LTCCS and NMVCCS Crash Studies

The approach of the LTCCS to crash causation is best described in “The Large Truck Crash Causation Study”, a paper by Daniel Blower and Kenneth L. Campbell of the University of
Michigan Transportation Research Institute. The NMVCCS employed the same methodology as the LTCCS. The authors make the point that factors such as those listed in the example above don’t automatically “cause” crashes, but do increase the risk of crashes. The goal of the LTCCS and NMVCCS was to identify the risk factors that make crashes more likely.

Three key elements were coded for each crash:

- **Critical Event**: the event that immediately led to the crash. The critical event is the action or inaction that put a vehicle or vehicles on a course that made the collision unavoidable. The event is coded to only one of the vehicles in each crash.

- **Critical Reason**: the immediate reason for the critical event. Possible critical reasons include driver errors, vehicle failures, and environmental conditions (weather or roadway). Only one critical reason is coded for each crash, and it is assigned to the vehicle that was coded with the critical event.

- **Associated Factors**: all person, vehicle, and environmental conditions present at the time of the crash from among all factors that are generally considered to be possible contributing elements to motor vehicle crashes.

Crash risk is usually defined as crashes per some measure of exposure or opportunity, often crashes per mile of travel. Exposure data on truck travel in the United States are crude. Some measure of crash factors such as driver and vehicle problems can be gathered from truck inspection stations, but trucks and their drivers are not selected for inspection through a random process. Non-random inspection choices are based on previous inspections, crash history, and inspector observations making the use of the results of these inspections for exposure problematic or unreliable. With regard to passenger vehicles, vehicle miles traveled is more reliable, but there is no routine inspection of such vehicles and their drivers traveling on the roadways to gauge the presence of crash factors among those not involved in crashes.

Induced exposure is a general technique that uses crash data to estimate relative exposure for a specific factor being examined. It assumes that the factor can affect only some crashes. The factor’s presence in crashes that it cannot affect serves as a measure of its presence on the road (its exposure); the relative risk of the factor is the ratio of its presence in crashes that it may affect to its presence in crashes that it cannot affect. In LTCCS and NMVCCS, crash vehicles can be divided into two groups: those that were assigned the critical reason and those that were not. When the presence of associated factors coded to the two groups is compared, the relative risk of each factor can be assessed, as illustrated by the following examples:

- If 30 percent of the drivers of passenger vehicles assigned critical reasons for crashes were using prescription drugs, and 30 percent of the drivers not assigned a critical reason were also using prescription drugs, we would conclude that prescription drug use is not a risk increasing driver factor for passenger vehicle drivers.

- If 15 percent of the drivers of large trucks assigned critical reasons for crash were fatigued, while only 5 percent of the drivers of large trucks not assigned critical reasons were fatigued, we would conclude that fatigue is a risk increasing factor for drivers of large trucks.
The Crash Causation Studies and Results

The LTCCS and NMVCCS were conducted in the first decade of the 21st Century employing the National Automotive Sampling System (NASS) of the National Highway Transportation Safety Administration (NHTSA). NASS was established to provide a national estimate of motor vehicle fatal, injury, and property damage only crashes. For the large truck study – a truck with a gross vehicle weight rating of over 10,000 pounds -- NASS selected 956 crashes in 2001-2003 that resulted in at least one fatality or one injury. For the motor vehicle study -- passenger cars, pickup trucks, vans, sport utility vehicles -- a sample of 5,470 crashes was selected in 2005-2007 resulting in at least one fatality, one injury, or one vehicle towed from the crash scene. In both studies NHTSA-employed contractors coded crashes for critical event, critical reason, and associated factors. About half of the crashes were coded by a contractor in Buffalo and half in San Antonio.

Following data collection and coding, the cases were weighted to provide estimates of all crashes that occurred during the periods of the studies. For example, during the 33-month period when data for the LTCCS were collected, NHTSA’s General Estimates System estimated that there were 120,000 large truck fatal and injury crashes in the United States. The 956 fatal and injury LTCCS cases were weighted to provide estimates of the crash characteristics of these 120,000 crashes. The weighting procedures are described in the LTCCS Analytical User’s Manual and the Sampling Design Used in the NMVCSCS.

The results for coding of the critical event and assignment of the critical reason in the two studies were similar. These results are discussed in detail in the paper “Distraction and Inattention; Top Crash Causes in the USA” by Ralph H. Craft and Brian Preslopsky. In the LTCCS when a large truck was assigned the critical event for a crash, 88 percent of the time the critical reason was assigned to the driver, 10 percent to vehicle failure, and 2 percent to environmental factors – roadway or weather problems. In the NMVCCS when a passenger vehicle was assigned the critical event, drivers were coded with the critical reason in 97 percent of the crashes.

The five associated factors with the highest risk in rank order in the LTCCS were driver inattention/distraction, inadequate surveillance, fatigue, illegal maneuver, and following too close. The five highest risk factors in rank order in the NMVCCS in rank order were inadequate vehicle control, inadequate surveillance, traveling too fast for conditions, alcohol, and illness.

A Danger Index was developed by combing the relative risk factor with how often the factor was coded in the two studies. The five associated factors with the highest Danger Index for large trucks in the LTCCS for drivers were traveling too fast for conditions, distraction/inattention, unfamiliar with roadway, inadequate surveillance, and fatigue. The five facts with the highest Danger Index for passenger vehicles in the NMVCCS for drivers were inadequate surveillance, distraction/inattention, inadequate vehicle control, physical impairment, and traveling too fast for conditions.
Federal Motor Carrier Safety Administration (FMCSA) Enforcement Dilemma

The United States Department of Transportation is responsible for ensuring that private transportation companies operate in a safe manor. The scope of the job differs among modes. For example, the Federal Aviation Administration must examine about a dozen major airlines, several dozen regional carriers, a small number of specialty air carriers, two major aircraft companies, and several companies that build limited passenger airplanes. The Federal Railroad Administration is responsible for six Class 1 carriers and several dozen short line railroads. The FMCSA is faced with ensuring the safety of about 500,000 interstate commercial truck and bus companies and their drivers.

FMCSA cannot visit every commercial motor carrier every year to assess safety programs, so they use all available data to try to identify unsafe carriers and review their safety procedures and records. The major databases are vehicle and driver safety inspections conducted by States, carrier and driver licensing information, and carrier and driver traffic violations, all of which are reported to FMCSA. Crashes are also reported to FMCSA by States. In 2017, 4,089 large trucks were involved in fatal crashes and an estimated 66,000 trucks involved in injury crashes. In-depth analysis of these crashes is impossible. Thus, FMCSA records all crashes to the carriers involved as a negative value when calculating carrier safety ratings. If a truck is stopped at a red traffic signal and rear-ended by another vehicle, that crash becomes a negative input in determining the safety rating of the truck carrier.

Moving from “Causation” to “Accountability”

FMCSA does not have the resources for in-depth evaluation of the causes in large truck crashes in even the 4,000 fatal crashes each year. But the LTCCS project concluded that when a large truck was coded with the critical event in a crash, the critical reason was coded to driver error in 88 percent of the crashes and to truck vehicle failure in 10 percent of the crashes. Thus, in 98 percent of the crashes, the motor vehicle carrier could be determined as being “accountable” for the crash without trying to determine the exact cause of the crash, since the carrier hires and trains the drivers and buys (or leases) the trucks and puts them on the highway.

To assess accountability the only coding needed would be the critical event. If the critical event is coded to the truck, and then the environment (roadway or weather) is eliminated as the critical reason (only 2 percent of the crashes), the motor carrier could be assessed as being responsible for the crash. The coding would not even have to determine whether the critical reason was driver error or vehicle failure. The issue then becomes is there a way to code the critical reason from a smaller amount of crash data.

The Test
Federal Motor Carrier Safety Administration (FMCSA) entered into a cooperative agreement with the National Highway Traffic Safety Administration (NHTSA) to test a method for coding motor carriers as being accountable or not accountable for large truck and bus crashes. The objective of the study was to determine the feasibility for accurately and consistently coding accountability from only a police accident report (PAR). The test for accountability was whether the large truck could be coded only with the critical reason from the data on the PARs. Critical reason thus becomes accountability – when a truck or truck driver is coded with the critical reason the motor carrier is coded as accountable for the crash.

The methodology tested here for the crash critical reason coding was that developed for the Large Truck Crash Causation Study (LTCCS). Crashes in the LTCCS were coded by NHTSA’s National Automotive Selective System (NASS) two zone centers in Buffalo and San Antonio. This test for coding critical reasons for crashes from just the PARs included 1,221 police reported crashes. There were five groups of crashes coded:

- 221 fatal crashes from the Large Truck Crash Causation Study (LTCCS),
- 200 A injury (incapacitating injury) crashes from the LTCCS,
- 200 B injury (non-incapacitating injury) crashes from the LTCCS,
- 200 C injury (possible injury) crashes involving at least one large truck from NHTSA’s General Estimates System (GES) database of crashes, and
- 400 property-damage-only (PDO) crashes that involved at least one large truck and one vehicle (not necessarily the large truck or commercial bus) being towed from the crash scene from the GES database.

For the 621 LTCCS fatal, A injury, and B injury crashes the coders from the NASS zone center that did not code the LTCCS cases based on all the crash data collected coded critical reason (accountability) using only the PAR data that was part of the LTCCS case file. For example, the crash critical reason coded in an original LTCCS case in the Buffalo zone in 2001-2003 was compared with the critical reason assigned by the San Antonio zone in the test based solely on data drawn from the PAR.

For the 600 C injury and PDO crashes the critical reason was coded by both NASS zone centers based solely on data from the PARs and the results were compared. The zone centers together developed a coding form to cover data collection from the PARs for all cases. An interview form was developed for 600 GES crashes, in case the coders believed they needed additional data to help determine the crash critical reason.

The methodology for coding a PAR for crash critical reason is not a cookbook exercise. Two members of the CSA2010 team and the author watched a NASS Zone Center 1 coder open several GES crash case PARs and code the crashes for critical reason. The coder had experience coding LTCCS and NMVCCS cases over a seven-year period. After a quick perusal of the PARs the coder carefully read the crash narratives, studied the crash diagrams, and reviewed every data element collected in the PAR. After considering all the data she used a crash reconstructive approach to put together a summary of the crashes in her mind, and made decisions on the assignment of critical reasons. Critical reason was the only variable coded for
in each case, but a quick explanation of the reasons behind the coding was often provided in a one or two sentence narrative for some of the crashes.

Results

The table below shows the degree of agreement and disagreement between the zone centers coding of all the 1,221 crashes. For the 621 LTCCS crash cases, agreement means that the critical reason assignment for a particular crash by the zone center staff who utilized only the PAR in the LTCCS database in 2008 was the same critical reason coded by the other zone center staff several years earlier using all the data from the LTCCS database (PAR included) for the case in question.

For the 600 crash cases taken from the GES database, agreement means that for the case in question the staffs of the two zone centers coded the same critical reason using only the PARs. (Note: All data in GES is coded just from PARs.)

<table>
<thead>
<tr>
<th>Crash Severity</th>
<th>Database</th>
<th>Number of Crash Reports</th>
<th>Did Coders Agree?</th>
<th>Total Trucks</th>
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<tbody>
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<td></td>
<td></td>
<td>Number of Trucks</td>
<td>Percent</td>
<td>Number of Trucks</td>
</tr>
<tr>
<td>Fatal</td>
<td>LTCCS</td>
<td>221</td>
<td>241</td>
<td>92.3%</td>
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<tr>
<td>A Injury</td>
<td>LTCCS</td>
<td>200</td>
<td>214</td>
<td>94.3%</td>
</tr>
<tr>
<td>B Injury</td>
<td>LTCCS</td>
<td>200</td>
<td>228</td>
<td>91.2%</td>
</tr>
<tr>
<td>C Injury</td>
<td>GES</td>
<td>200</td>
<td>189</td>
<td>91.3%</td>
</tr>
<tr>
<td>PDO Towaway</td>
<td>GES</td>
<td>400</td>
<td>411</td>
<td>95.1%</td>
</tr>
</tbody>
</table>

Totals 1,221 | 1,283 | 93.2% | 94 | 6.8% | 1,377 |

Explanatory notes on the table:
- Number of crash reports refers only to the PARs, even though the LTCCS files had much more data than just PARs.
- While there were 1,221 crash cases, the number of trucks and buses involved in the cases was 1,377. A number of crashes involved more than one truck or bus, and accountability was coded for every one of these vehicles. For simplicity sake the
“trucks” is used instead of “vehicles” in three columns, since there were 24 buses involved in the crashes.

- Tractors pulling a single semi-trailer made up 67.6 percent of the trucks involved in the crashes. Single unit trucks were 21.9 percent of the trucks, and other trucks 10.5 percent.

The 93.2 percent agreement between zone centers on coding accountability seems very good. Discussion between zone centers concluded that the degree of agreement would increase with the development of a coding manual specifically for coding crashes from just PARs. The manual used for this test was developed for the Large Truck Crash Causation Study.

A revised coding manual for assigning accountability would be considerably shorter, since crash associated factors would not be coded. The manual could also include several changes to the LTCCS and MNVCCS methodology to better reflect crash accountability. The single largest change would be the addition of right-of-way in the determination of critical reason. Several other minor changes would be made. The new codebook could be available to train new coders for assessing accountability.

One major concern at the beginning of the test was that for more minor crashes the PARs would not contain enough information for coding accountability. That did not prove to be the case. The percentage of agreement in the study does not go down as the crash consequences become less serious, as can be seen the table. Coders were surprised to see the high quality of the data in PARS for minor injury and property-damage-only crashes. One possible explanation is that when officers are confronted with crashes involving large vehicles, such as 18-wheelers, they may take more care in completing PARs.

Implications

The test demonstrated that coding the critical reason, and thus accountability, from just Police Accident Reports (PARS) is feasible in a large majority of crashes. Coding crashes involving interstate motor carriers for accountability could add an important factor in the calculation of carrier safety ratings by the Federal Motor Carrier Safety Administration.

A system using two coders for every crash could result in the assignment that a carrier was accountable, not accountable, or accountability could not be determined. That later result could mean that the two coders disagreed on the assignment of accountability or there was insufficient data in the PARs to make a decision. An alternative method would have one coder make the accountability assignment in each case, and have the difficult cases reviewed by a small panel.

References


