Overview of the University of Michigan Transportation Research Institute Large-Truck Survey Program

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ABSTRACT

The Statistical Research Group of the Michigan Transportation Research Institute (UMTRI) has been conducting a nationwide survey program to address large-truck safety issues in the United States. Among the principal sponsors of the program are the Motor Vehicle Manufacturers Association, American Trucking Association, the Western Highway Institute, and more recently, the Engine Manufacturers Association. Some planned analytic work is to be supported by a contract with the National Highway Traffic Safety Administration of the U.S. Department of Transportation.

In 1981 a survey of all large trucks involved in fatal accidents in the United States was initiated with 1981 being the first accident year covered. This survey combines information from the U.S. Department of Transportation National Highway Safety Administration (NHTSA) Fatal Accident Reporting System (FARS), the Federal Highway Administration Bureau of Motor Carrier Safety, police accident reports, and telephone surveys conducted by UMTRI, to produce a comprehensive data file called Trucks Involved in Fatal Accidents. In 1985 the National Truck Trip Information Survey (NTTIS) was initiated. For this survey, the owners of over 4000 large trucks are being contacted four times over a twelve-month period to obtain detailed information on the use of the truck on a randomly-selected survey data. The information collected includes the configuration, cargo, actual weight, and the route the truck followed. The combination of the accident data with miles traveled from NTTIS will enable the calculation of fatal accident involvement rates by vehicle type, road class, etc. The crashworthiness of the truck cab is being assessed in a survey collecting information on the severity of the collision and on the injuries to the truck driver. These programs are supported by gifts from the Motor Vehicle Manufacturers Association, the American Trucking Associations, the Engine Manufacturers Association, the Western Highway Institute, and, under contract, by the National Highway Traffic Safety Administration. This year, the State of Michigan is supporting an extension of the accident survey to non-fatal truck accidents in the state, and General Motors is supporting a project to conduct on-scene investigations of selected large-truck accidents involving a fire. Current analytical work includes statistical modelling of factors related to rollover, comparison of accidents by road class, analysis of involvement rates and accident severity for single- and twin-trailer vehicles, and analysis of truck accident trends in Michigan. In addition to an overview of the program, preliminary results of the research on single versus double trailers and on the probability of rollover in a collision will be presented.

OBJECTIVES OF THE PROGRAM

When UMTRI began designing its large-truck survey program, in 1979, the existing information on the safety experience of large trucks in the U.S. was very limited. The prevailing judgments on large truck safety were based mainly on the opinions of lobbying groups, on faulty research (1), or on data with incomplete coverage such as the BMCS accident reports. UMTRI believed that a long-term program was needed to address many of the safety issues concerning large trucks, and that such a program would have to focus initially on generating high-quality data on accident involvement and usage.

Many of the studies in the area suffered (and still suffer) from the flaw of addressing only one issue at a time, whether it was driver licensing, or fatigue, or vehicle weight, or number of trailers. Such an approach neglects the inter-relatedness of many of the factors being evaluated in examining truck safety. For example, twin-trailer units are longer and heavier than single-trailer units and may have an elevated risk of rollover, but they tend to be driven mainly on the relatively safe

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interstate-quality roads and are assigned to more experienced drivers. UMTRI determined that the first priority was to address the size, weight, configuration, and use of large trucks. The aim was to assess the relative over- or under-involvement of different kinds of trucks in serious accidents, after controlling for environmental factors such as road class, time of day, etc. It was hoped that differences in accident involvement rates could be related to the physical characteristics of the truck which were being explored in a concurrent research program by UMTRI's Engineering Research Division. Differences that could not be so explained would become candidates for further research focusing more, perhaps, on driver issues and vehicle condition.

DATA COLLECTION PROGRAMS

UMTRI decided to tackle the accident data before the exposure data. This was partly because of the long lead time required to design and prepare a national exposure survey (two to three years is a minimum) and partly because it was felt that the accident statistics alone would provide useful safety information. The discussion later in the paper on the probability of rollover is an example of the kind of analysis work that can be performed on accident data. But given the decision to focus initially on improving the quality of the accident data, there remained the problem of how to do this.

No national database of large truck accident involvements existed that had both comprehensive coverage and a detailed description of the truck. For example, the BMCS accident reports cover both property-damage and injury accidents and contain a detailed description of the truck, including number of trailers, cargo, empty weight, and cargo weight. The BMCS data do not, however, cover intrastate-only carriers and suffer from under-reporting by private interstate carriers. The FARS data nominally provide complete coverage of all involvements in fatal accidents, but pay short shrift to the description of the truck. UMTRI decided to provide a dataset that combined the coverage of FARS with the descriptive detail of BMCS. The FARS file would be used as the starting point in selecting cases for follow-up and it would be assumed that FARS provided a complete census of fatal accidents. Limiting the information to involvements in fatal accidents was perhaps not ideal. It did, however, offer the advantage of convenience in that no other national sampling frame of truck involvements existed. It was also the case that involvements in fatal accidents constituted a large proportion of large-truck involvements in serious injury accidents. Using information from the National Accident Sampling System for 1981 through 1984, it is possible to calculate the proportion of all large-truck involvements in accidents that result in a serious injury (defined as AIS-3 or greater) that also result in a fatality. For all large trucks, the fatal involvements constitute 29 percent of the serious-injury involvements; for tractors, they constitute 32 percent. Thus the involvements reported by FARS represent almost a third of the national total of large truck involvements in serious-injury accidents.

TRUCKS INVOLVED IN FATAL ACCIDENTS (TIFA)

The TIFA database is currently complete for accident years 1980 through 1983. The information is obtained through extensive follow-up on all large trucks that are recorded by FARS. The dataset provides detailed descriptions of all medium and heavy trucks (greater than 10,000 lbs. gross vehicle weight rating) that were involved in a fatal accident in the continental United States, excluding Alaska. To produce the file, BMCS reports are first matched to FARS cases; for cases that cannot be matched, telephone interviews are conducted to obtain company and vehicle descriptions. Extensive editing and consistency checking is performed on all information obtained by interview. For example, VINs are decoded to confirm that the make and model information and the power unit description conform to published model specifications. UMTRI has acquired an extensive database on cargo weights and densities so that a cargo weight can, if necessary, be imputed from information on cargo type and volume. For cases matched with BMCS reports, the BMCS descriptions of vehicle type are checked for reasonableness and consistency with FARS.

The database documents roughly 5,000 involvements per year. Each of these involvements was originally obtained from FARS, but some cases were subsequently dropped because they were identified as not being medium or large trucks or because they were not involved as traffic units. Overall, only some 87 percent of FARS identifications of large truck combination type are determined to be correct. Each year, some cases described by FARS as having a gross vehicle weight rating over 10,000 pounds are discovered to be in fact light trucks, while other cases described by FARS as being light trucks are found to be medium or heavy trucks.

The final TIFA datasets have all the information at the vehicle level. They provide all the original FARS variables describing the accident, vehicle, and driver together with the information from the UMTRI follow-up and the appropriate BMCS reports. For information pertaining to the vehicle, the new TIFA fields are both more detailed and more accurate than the minimal FARS description. In the belief that the FARS description of the accident environment and of the accident event is essentially accurate, such information is not duplicated in UMTRI's follow-up.

TIFA datasets have been prepared for each accident year from 1980 through 1983. In addition, UMTRI has combined the individual years into a single four-year file containing information on 19,962 large-truck fatal involvements. Special data files have also been prepared for all two-vehicle accidents. These data files are accident level files, and as such, each record contains information on each of the two vehicles involved in the accident, and their respective drivers. The first of these documents all two-vehicle accidents which involve a collision between a medium or heavy truck and some other type of vehicle (mostly passenger cars). The information on each of these accidents has been formatted to give first the information on the medium or heavy truck and its driver from the TIFA file, followed by the FARS descriptive information on the other vehicle and its driver. The second of these two-vehicle files is called Truck-Truck Fatal Accidents. It provides detailed descriptions on all fatal accidents involving two medium or heavy trucks. For this file, all of the vehicle descriptive information from the TIFA data is available for each vehicle.

The existence of the various TIFA files opens up new possibilities for the researcher who wishes to examine truck accidents. For the first time, detailed and accurate information describing the truck and its cargo is available for a nationally representative group of accidents.

NATIONAL TRUCK TRIP INFORMATION SURVEY (NTTIS)

In order to assess vehicle safety, information is needed on vehicle exposure to accidents (travel) as well as on vehicle involvement in accidents. Here too the existing data was found to be inadequate. In particular, the Truck Inventory and Use Survey (TIUS) conducted by the Bureau of the Census in 1977 and 1982 asks vehicle owners about the overall annual mileage of a truck and about its typical use. Minority kinds of usage, such as mileage with a single trailer by a tractor that typically pulls twin trailers, is thus omitted. TIUS can also not provide a detailed breakdown of truck use by cargo and cargo weight, by highway type, by driver age, and by time of day. Since these factors also influence the likelihood of accident involvement for trucks, an alternative methodology to provide this level of detail was necessary.

To meet these needs UMTRI has developed its own survey of truck usage. This survey is based on acquiring information at the trip level rather than at the level of a vehicle's annual mileage. The owner of each vehicle is being contacted by phone four times in a year and asked about the vehicle's usage on a randomly assigned date in the three-month period. The calls are being made as close to the assigned date as possible. For each day, the owner is asked to describe every trip made and to provide information on trailer usage (if any), cargo and cargo weight, and driver age. The trips are being split into daytime and nighttime mileage, and each trip is mapped on special atlases developed by UMTRI to distinguish urban from rural highways according to Federal Highway Administration definitions. Roads will also be divided into limited access highways, other major highways, and other roads.

By summing across trips, it will now be possible to provide estimated annual mileage by company type (intrastate or interstate, private or for-hire), power unit type, number of trailers, trailer type and trailer body, cargo, actual cargo weight and actual combination gross weight, driver age, day versus night, and highway type. Thus analysis of the safety of large trucks will be able to examine all these factors both in the accident data and in the exposure date.

The sample of vehicles was drawn from the state registration files maintained by R.L. Polk, using a data processing and sampling procedure designed by UMTRI. The procedure resulted in the selection of 8,144 vehicles. The initial contacts with the vehicle owners to obtain descriptions of each vehicle and information on the company operating the vehicle have been completed. Survey responses from the initial contacts produced estimates of the number of large trucks in the United States (2). These estimates contributed to a resolution of differences in population estimates developed by the Federal Highway Administration and the Bureau of the Census.

Survey calls are now being made to obtain the detailed travel information for the randomly as-

signed dates. Two quarters of data collection on vehicle mileage for the tractors and one quarter for the straight trucks have been completed. Response rates on the trip call have been very encouraging: they average around 85 percent which approaches the 1982 TIUS response rate of 90 percent in a survey where response is required by law. The complete data for the tractors are expected to be ready for analysis early in 1987, with the straight truck data ready three months later.

ANALYTIC WORK

UMTRI has, as part of the current program, performed analysis on a wide range of issues. The recent work on the relative safety of single- and twin-trailer vehicles and on the probability of rollover is discussed in more detail below. Here, a few highlights of other recent analyses will be outlined.

One continuing area of research has been large-truck crashworthiness. An earlier paper investigated the relationship of ejection and rollover to large-truck occupant fatality (3). The principal finding was that one-third of large-truck occupant fatalities are associated with ejection and two-thirds are associated with ejection and/or rollover. More recently, UMTRI has been investigating injury mechanisms for drivers who stay inside the cab in a collision. Here the focus has been on frontal collisions with no rollover. A special survey has been designed and is being conducted to collect information on injury contact point and crash energy.

Perhaps more notorious has been the investigation of the relationship between fires and fatality in collisions involving tractor-semitrailers (4). Here the finding was that 16 percent of the driver fatalities are associated with fires in the truck and that the fire fatality rate per mile traveled was 2.6 times as great in tractor-semitrailers as in passenger cars. A number of suggestions were made on further research to explore the mechanism of the fire in more detail.

Current work includes an examination of the effect of road class on accident type. Roads have been separated into four classes according to whether they were divided or undivided and urban or rural. The rural undivided roads were found to account for 48 percent of all large-truck fatal involvements, while rural divided roads accounted for only 20 percent. Several accident, vehicle, and driver factors were examined to see how they varied across road class. One finding was that, on all classes of road, accidents at dawn seem to be associated with fatigue, but that 60 per cent of the involvements at dawn occur to drivers who have been at the wheel for two hours or less. This suggests that driver fatigue is not just a simple product of long hours of driving.

Our most recent study was of truck accident trends in Michigan (5). The principal finding was that the recent, observed increases in large-truck involvements in the state were broadly in line with national and regional trends. There did appear, however, to be a growing problem of under-reporting of accidents by interstate carriers to BMCS.

Finally, it is perhaps appropriate to mention that UMTRI maintains a general expertise in the large-truck safety area. In particular, we have, over the years, developed a familiarity with the relevant existing databases such as the BMCS accident reports and the Truck Inventory and Use Surveys. With many of these databases, we have conducted extensive internal cross-checking of the data. Sometimes we are able to validate one data source against another, either on aggregate results, or, occasionally, on a case-by-case basis. This qualitative knowledge of the resources available equips us for rapid response to issues as they develop.

SAFETY COMPARISON OF SINGLE- AND TWIN-TRAILER VEHICLES

As part of UMTRI's contract with the Federal Highway Administration (FHWA) to develop an improved dolly for coupling the second trailer in a twin-trailer combination, UMTRI has been conducting a safety evaluation of current single-trailer and twin-trailer vehicles in an effort to determine the potential safety benefit of a new dolly. A number of such studies already exist, and most if not all of these are being evaluated in the current Double Trailer Truck Monitoring Study by the Transportation Research Board. However, more recent data than that used in the earlier studies was available both for accident and for exposure information, and it seemed worthwhile, therefore, to conduct a new analysis.

Before presenting some of the results, it is perhaps appropriate to raise the question of what hypothesis we should be testing in comparing the safety records of single- and twin-trailer combinations. The key here is to consider the influence of all the factors that might determine the overall

accident involvement rates for the two types of vehicle. Traditionally the focus has been an expectation that doubles might have a higher accident involvement rate than singles and, therefore, that a finding of no difference between the two classes of vehicle was favorable to the doubles. A more realistic expectation is that doubles ought to have a lower involvement rate than singles and that a finding of no difference is unfavorable to the doubles. This revised expectation is based on the generally safer operating environment for doubles: not only do many companies assign their better and more experienced drivers to twin-trailer vehicles, but these vehicles are driven mainly on relatively safe limited-access roads.

The new data files available for accident information were the multi-year TIFA datasets and data on large trucks from the U.S. Department of Transportation's National Accident Sampling System (NASS). NASS is a statistical sample of all police-reported accidents in the U.S. and accidents involving large trucks are sampled at a somewhat higher rate than most other accidents. For exposure information, the principal source of new information was the 1982 Truck Inventory and Use Survey (TIUS) conducted by the U.S. Bureau of the Census. The new TIUS was not only more current than the earlier 1977 study. It also provided proper identification of single-trailer and double-trailer tractor combinations where the earlier survey had not done so.

With the potential to incorporate in the analysis several different accident databases (TIFA, NASS, and BMCS), some procedure was needed to validate the various sources and assess their quality and utility. The best means to do so seemed to be to examine the reasonableness of the results obtained and to attempt to reconcile results from different sources. Where the results appeared absurd or the sources could not be reconciled, one source or another would be rejected. Since the TIFA data were believed to be complete and accurate, they provided a convenient yardstick for the assessment of NASS and BMCS.

Tables 1 and 2 show the comparison between NASS and BMCS on the one hand and TIFA on the other. They also show the number of involvements reported at different accident severities. Because of the small number of large-truck involvement cases in any single year of NASS, a four-year file of all the tractor-trailer involvements was created. The counts obtained are shown in Table 1 and the good correspondence on the fatals between NASS and TIFA should be noted. This shows that, in spite of small sample size, the NASS estimates for tractor involvements at the fatal level, and by inference at the injury level, can be trusted.

If we use the TIFA numbers for fatal involvements and combine them with the NASS estimates of injury and property-damage involvement, we can calculate a ratio of property-damage to injury to fatal involvements for each class of vehicles. This works out to 36:16:1 for the singles and 10:17:1 for the doubles. If these numbers are to be believed, then for every fatal involvement of a single there are sixteen injury involvements and thirty-six property-damage involvements. For each doubles fatal involvement, there are seventeen injury involvements and ten property-damage involvements. The very large difference between the two classes of vehicle in the ratio of property-damage to fatal involvements does not seem credible. It seems likely that this difference is an artifact of the data and is attributable to doubles units not being identified in NASS property-

Table 1 — Tractor-trailer accident involvements by data source and number of trailers

	Number of trailers	
Data source	**Single**	**Double**
NASS 1981-81[1]		
Property damage only	465,521	5,996
Injury (excl. fatal)	219,486	10,898
Fatal	12,806	673
TIFA[2]	13,103	627

1 The cases in NASS where the vehicle had a trailer but the number of trailers was unknown were distributed proportionately to the cases with a known number of trailers within each accident severity level.

2 The numbers in the TIFA file for 1981 through 1983 were inflated to four-year estimates.

Table 2 — ICC authorized tractor-trailer accident involvements by data source and number of trailers

	Number of trailers	
Data source	**Single**	**Double**
BMCS 1980-83		
Property damage only	39,673	1,968
Injury (excl. fatal)	41,071	1,786
Fatal	5,106	241
TIFA 1980-83	6,475	296

damage accidents. NASS has difficulty in identifying any kind of large truck in an accident because the vehicle has frequently left the area before the investigation begins. It seems reasonable that this problem would be more acute in the less severe accidents and that doubles, which are more likely to be long-haul, would have a greater tendency than singles to have left the area. Therefore, the NASS estimates of property-damage accident involvement will be excluded as unreliable.

In Table 2, BMCS counts of involvements for tractors with trailers are shown by accident severity and number of trailers. They can be compared with numbers obtained from the TIFA database. Because of known under-reporting of accidents to BMCS by non-authorized carriers, the counts have been restricted to the ICC authorized carriers. The TIFA numbers have been similarly restricted. Comparing the BMCS counts of fatal accident involvements with the numbers from TIFA, it is clear that even for fatal accidents there is a certain amount of under-reporting. However, this under-reporting is almost identical for the singles and the doubles: for the former it is 21.1 percent and for the latter 18.6 percent. Thus any estimates of injury accident involvement rates derived from BMCS are not likely to suffer from differential reporting. There does, however, appear to be very substantial under-reporting of property-damage accidents to BMCS. Even given the reporting threshold of $2,000 of damage, the roughly equal numbers of injury and property-damage accidents do not seem very credible. Thus it seems appropriate not to use the BMCS property-damage accidents for the calculation of involvement rates.

Table 3 combines counts of tractor-trailer fatal accident involvements from TIFA with exposure estimates from the 1982 TIUS to provide fatal accident involvement rates. Using 1982 TIFA alone, the doubles units appear to have a slightly lower rate of fatal accident involvements, both overall and for the vehicles operated by the ICC authorized carriers. However, if we instead use accident data from three years because of the relatively small number of doubles units involved in fatal accidents in a single year (130 in 1982), the doubles have a slightly higher rate overall, but a somewhat lower rate for the ICC authorized carriers. A reasonable conclusion would be one of no difference in fatal accident involvement rate between the singles and doubles.

Table 4 provides rates of involvement in accidents that resulted in at least one injury. The two sources of the involvement counts here are the 1981-84 combined NASS file and the 1982 BMCS file limited to ICC authorized carriers only. Here the doubles have a slightly lower rate, but the difference is small enough and the data quality is uncertain enough to lead to a conclusion of no difference in injury accident involvement rates. Thus the overall assessment is one of no difference in either fatal or injury accident involvement rates between singles and double. It does seem possible that, particularly for the ICC authorized carriers, the doubles may have a somewhat lower rate. The rates for the ICC authorized carriers derived from the 1982 TIFA and BMCS files suggest that the ICC doubles may have a 21 percent lower fatal accident involvement rate and a 14 percent lower injury accident involvement rate than the ICC singles. Given the fact that many carriers assign their more experienced drivers to their doubles units, and that the doubles operate more on relatively safe interstate-quality roads, the conclusion of no difference or of a slightly lower rate for the doubles does not seem all that favorable to the twin-trailer units.

To substantiate the assumption that the doubles are operated more on better-quality roads, the distribution of involvements by road class was ascertained. In the absence of real estimates of exposure by road class, the accident data can serve as a surrogate. Clearly the distribution of involvements by road class is related to the relative usage by road class and, if a relatively safe class of road accounts for a much larger share of the involvements for one class of vehicle than for another class of vehicle, this can only be explained by travel patterns.

Table 5 shows the proportions of fatal accident involvements by road class for the singles and

Table 3 — Tractor-trailer fatal accident involvement rates by data source and number of trailers

Data source for involvement counts	Number of trailers: Single	Double
TIFA 1982		
All	6.9	6.7
ICC only	9.8	7.7
TIFA 1980-82		
All	7.2	7.6
ICC only	9.7	8.6

NOTE: Rates are per 100 million miles.

doubles. Forty-eight percent of the doubles fatal involvements occur on divided roads as opposed to 41 percent for the singles. Table 6 shows the same comparison using all BMCS-reported involvements by ICC authorized carriers. Here a remarkable 70 percent of the doubles involvements are on divided roads as compared to 52 percent of the singles involvements. Given the relative safety of the divided roads, it is probable that well over three-quarters of the ICC authorized doubles' travel is on divided roads.

The distributions of involvements by road class point out the need for more detailed exposure data of the kind being collected through NTTIS. The problem here is that the overall involvement rates for singles and doubles may indicate little or no difference in safety between the two classes of vehicle. However, a qualitative consideration of the likely effect of such factors as road class suggests that involvement rates under comparable operating conditions will prove to be less favorable to the doubles.

THE PROBABILITY OF ROLLOVER

Analysis of the accident data in the TIFA files can provide some insight as to the relationship of vehicle configuration to accident experience. Currently, we are looking at the probability of rollover in fatal accidents in relation to vehicle configuration. The vehicle parameter that is expected to influence rollover the most is the height of the centre of mass. The height of the centre of mass is, in turn, related to the trailer body style. Table 7 shows the probability of primary and secondary rollover for various tractor-based configurations in the three-year TIFA file covering 1980 through 1982. When the rollover is the primary collision event, it is coded by FARS as a "first-event" rollover. Rollover is described as a "subsequent event" when the rollover is secondary, or subsequent, to some other collision event. The figures shown in the second column of Table 7 are the total number of vehicles of each configuration involved in fatal accidents during this three-year period. In total, this table shows the probability of rollover for 10,845 tractor combinations. Overall, rollover was the primary collision event for 6.3 percent (683) of the tractor-combinations involved in fatal accidents, and was a secondary collision event for an additional 10.9 percent (1182).

The TIFA files developed at UMTRI are the only national data that identify specific truck configurations, as shown in Table 7. In general, missing data is very low in the TIFA files. Missing data on cab style is 8 percent in this table, and most of this is from the 1980 accident year, since the missing data for cab style was reduced in the subsequent years. Missing data on most variables is now below 5 percent. The probability of rollover in Table 7 is different for the various configurations shown. Other than a very small group of bobtail tractors of unknown cab style, conventional-cab tractors with a single, van trailer have the lowest probability of primary rollover at 3.5 percent. The probability of primary rollover for cabover tractors pulling two van trailers is only slightly higher at 3.9 percent. Cabover tractors pulling flatbed and tank trailers have virtually the

Table 4 — Tractor-trailer injury (incl. fatal) accident involvement rates by data source and number of trailers

Data source for involvement counts	Number of trailers: Single	Double
NASS 1981-84 (All)	123.2	115.5
BMCS 1982 (ICC only)	72.0	61.7

NOTE: Rates are per 100 million miles.

Table 5 — TIFA 1980-82: tractor-trailer fatal accident involvements by road class and number of trailers

	Number of Trailers: Single		Double	
Road class	N	%	N	%
Divided	4,057	40.9	215	48.0
Undivided	5,783	58.3	231	51.6
Unknown	74	0.7	2	0.4
Total	9,914	100.0	448	100.0

Table 6 — BMCS 1984: ICC authorized tractor-trailer accident involvements by road class and number of trailers

	Number of trailers: Single		Double	
Road class	N	%	N	%
Divided	12,924	51.8	954	70.1
Undivided	10,265	41.1	361	26.5
Unknown	1,778	7.1	45	3.3
Total	24,967	100.0	1,360	100.0

highest probability of primary rollover, which is a little over 10 percent. Their probability is exceeded only by that of a small group of double-trailer combinations with unknown cabstyle. The probability of secondary rollover is virtually the highest for cabover tractors pulling a single, tank trailer and cabover tractors pulling two van trailers at 19.0 and 18.3 percent respectively, exceeded only by that for a small group of double-trailer combinations of unknown cabstyle.

Other characteristics of the configuration of the vehicle are also expected to influence the probability of rollover. For a given trailer body style, the height of the centre of mass is generally expected to increase with the cargo weight, or gross combination weight. The probability of rollover for tractors with single trailers was tabulated separately for various ranges of gross combination weight at the time of the accident. The results, plotted by trailer body style, are shown graphically in Figure 1. Weight is shown to have a strong influence on the probability of rollover in fatal accidents. Although one might have expected drivers to be aware of the rollover threshold of their vehicle, and to compensate accordingly, the results shown in Figure 1 underscore the relationship of the physical characteristics of the vehicle and its accident experience.

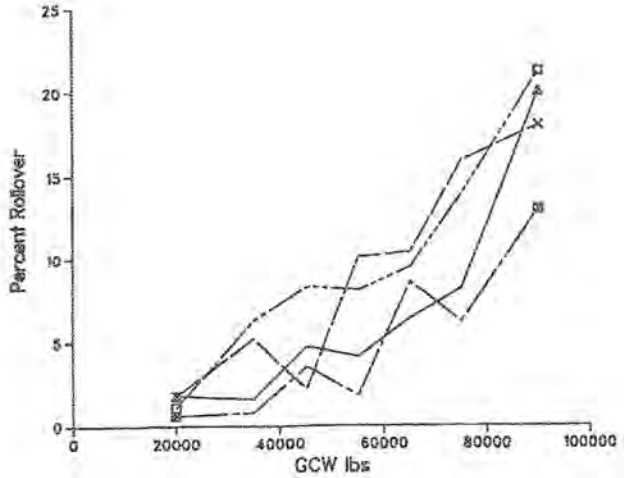
Although rollover may be viewed as being primarily related to the trailer, the ability of the tractor to resist overturn will also have an influence. Longer wheelbase tractors will generally resist rollover better. The tabulation of rollover probability by gross weight and cab style, shown in Figure 2, is consistent with this view.

Other factors, such as the pavement coefficient of friction, will also affect the probability of rollover. The probability is expected to be somewhat lower on surfaces with a low coefficient of friction, since the trailer tires will tend to slide sideways rather than to adhere and cause the trailer to overturn. Indeed, when the accident data is tabulated separately for dry and wet pavement, the overall probability of rollover decreases from 6.0 to 3.9 percent for conventional-cab tractors with single trailers, and from 7.1 to 5.3 percent for cabover tractors with single trailers. Road class also influences the probability of rollover, with most of the rollovers occurring on rural roads.

Looking at each of the factors that influence rollover in one- or two-way tabulations is useful as a preliminary indication of their effect. However, when one realizes the number of factors involved, reliable conclusions cannot be drawn. Is the higher probability of rollover for cabover tractors a reflection of the influence of a shorter wheelbase, or a reflection of more travel on rural roads? A multivariate analysis that takes into account the influence of all the significant factors simultaneously is necessary to determine the relative effect of each factor individually, and in combination with other factors. For example, the probability of rollover on interstate roads changes little depending on whether the road is in an urban or rural area. For all other highway types, this influence is substantial. The development of multivariate models that will allow the effects of each factor to be estimated individually and in combination with the other factors is one of our current efforts.

Table 7 — TIFA 1980-82: probability of rollover for tractors by configuration

		Percent of rollovers		
Configuration	**N in subset**	**None**	**First event**	**Subsequent event**
Bobtail	382	77.7	7.3	14.9
Conventional	136	80.9	7.4	11.8
Cabover	213	75.6	8.0	16.4
Unknown Cab	33	78.8	3.0	18.2
One Trailer	9951	83.2	6.3	10.5
Conventional	4180	85.1	5.6	9.2
Van Body	1328	87.0	3.5	9.4
Flatbed	823	84.4	7.8	7.8
Tanker	706	79.5	8.5	12.0
Other Body	1120	86.6	4.6	8.8
Unk. Body	203	86.7	6.4	6.9
Cabover	4982	81.8	6.8	11.4
Van Body	2646	84.2	5.2	10.6
Flatbed	1106	79.2	10.3	10.5
Tanker	305	70.8	10.2	19.0
Other Body	644	81.2	6.1	12.7
Unk. Body	278	82.7	6.1	11.2
Unknown Cab	789	81.6	6.5	11.9
Two Trailers	455	80.0	5.1	14.9
Conventional	100	85.0	4.0	11.0
Cabover	328	80.5	4.9	14.6
Van Body	153	77.8	3.9	18.3
Other Body	175	82.9	5.7	11.4
Unknown Cab	27	55.6	11.1	33.3
Other Type	57	86.0	5.3	8.8
All	10,845	82.9	6.3	10.9

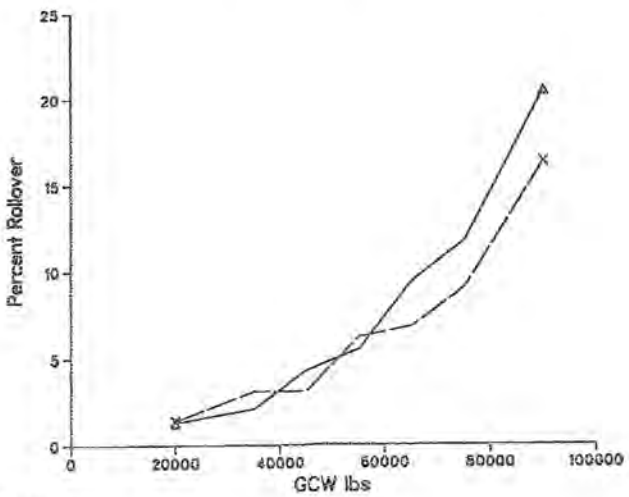


Legend

Δ	Van	×	Flatbed
❑	Tanker	❑	Other

TIFA 1980-82: Probability of first-event rollovers in tractor-semitrailer involvements by gross combination weight and trailer body size

FIGURE 1



Legend

Δ	Cabover	×	Conventional

TIFA 1980-82: Probability of first-event rollovers in tractor-semitrailer involvements by gross combination weight and cab style

FIGURE 2

PLANS FOR THE FUTURE

UMTRI currently has plans for the expansion of its large-truck survey program in three ways:

1. In scope, to broaden the coverage of accident involvements to include injury-level data in addition to the current concentration on fatal involvements.

2. In topic area, to bring in some of the driver issues such as years of experience and the issue of the influence of vehicle condition on the probability of being involved in an accident.

3. In analysis techniques, to use time-series methods, once we have sufficient longitudinal data, to address questions of trends in large-truck accident involvement.

In a way, the UMTRI survey program is at a crossroads now. We have achieved many of our initial goals in establishing an on-going and reliable accident survey and in conducting the first national exposure survey capable of addressing many of the issues that have been prevalent for so long. We are grateful for the support we have obtained, in particular from the Motor Vehicle Manufacturers Association which has been the mainstay of our program. However, even digesting all the information we will soon have, let alone broadening the scope of the program to include new issues, will require even greater resources. If the program is to continue, it requires a broader base of support.

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