UMTRI-90-1-2

THE MICHIGAN HEAVY TRUCK STUDY

EXECUTIVE SUMMARY

A Joint Project of

Michigan State University
Department of Civil and
Environmental Engineering

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16. Abstract

This report presents an analysis of the travel, crash frequencies, and crash rates of large trucks registered in Michigan. The project focused on the travel and crashes of Michigan-registered trucks in Michigan. The travel data are from the UMTRI Michigan Truck Trip Information Survey (MTTIS). Crash frequencies are from the computerized file of police accident reports maintained by the Michigan State Police, supplemented by data on the state-of-registration of involved trucks compiled by Michigan State University. The project was undertaken jointly by UMTRI and the Michigan State University Department of Civil and Environmental Engineering.

The research approach and survey methods are described. Estimates of the travel and population of Michigan-registered tractors are presented, along with crash frequencies for several subsets of interest. The factors addressed in the risk analysis are: truck type, crash severity (fatal, injury, property-damage-only [PDO]), road type (limited access, major artery, other), urban/rural, day/night. The results indicate that the bobtail tractor configuration has the highest risk on all parts of the Michigan highway system. Crash rates for singles and doubles are quite similar overall, though the doubles rate is higher for casualty crashes on major artery and other roads. Limited access roads had the lowest rates, followed by major arteries, and other roads. Crash rates were lower in urban areas than rural. Overall, daytime rates were higher than nighttime. Casualty crash rates were higher at night, but PDO rates were higher during the day in both urban and rural areas, but particularly urban. Traffic density appears to explain the higher overall daytime rate.

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SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

1. Introduction

Major changes have taken place in the trucking industry over the past several years. In 1980, federal legislation significantly relaxed the regulation of trucks in the interstate segment of the industry, and the 1982 Surface Transportation Assistance Act (STAA) allowed the use of double-trailer combinations on interstate highways, required states to regulate trailer length instead of overall length, and established the Motor Carrier Safety Assistance Program (MCSAP). More recently, the Commercial Motor Vehicle Safety Act of 1986 established national standards for commercial driver licenses.

Not all of the national changes had the same impact on Michigan since the state has long had some of the most liberal truck size and weight regulations. For example, double-trailer combinations weighing up to 164,000 pounds have operated legally in Michigan for many years. In fact, since states bordering Michigan have had more restrictive regulations, a significant, and unique, intrastate industry segment has existed in Michigan. Notwithstanding the existence of this intrastate fleet, national deregulation will still affect truck operations in Michigan. The use of double trailers and the experience of other combinations operating in Michigan is of significant interest both within the state and nationally.

At the same time, there is the general perception that large trucks are simply not safe—there are questions about the safety of these vehicles and what, if anything, should, or can, be done to make them safer. The actual "numbers" in Michigan show that crashes involving large trucks increased 81% from 1982 to 1986, but then decreased in 1987 and 1988. For the entire period from 1982 to 1988, the number of truck crashes increased by 64%. During the same period, *all* traffic crashes increased by about 40%. Over the same period of time, economic conditions have improved substantially in the state, as has truck travel. In the face of so many changes, the problem is to identify the significant factors associated with truck crashes.

Despite the high interest in truck safety, there are still significant gaps in the current knowledge about truck crash rates and the causal factors involved—both nationally and in Michigan. In this context, a joint project by the University of Michigan Transportation Research Institute and the Michigan State University Department of Civil and

Environmental Engineering was undertaken to develop statistical information on crashes, travel, and the risk of crash involvement for Michigan-registered trucks in Michigan. Operationally, the objectives of the study can be defined as calculating disaggregate truck crash rates (in terms of crash involvements per million vehicle-miles traveled) for combinations of the following variables:

truck types	1. bobtails—tractors without trailers, 2. singles—tractor and semitrailer combinations, and, 3. doubles—tractor, semitrailer, and full-trailer combinations;
roadway types	1. limited—free, limited access highways, 2. major—principal and other through highways and other four-lane divided highways (not included in 1), and, 3. other—all other streets and roads;
rural/urban	1. rural—population code of 2,500-5,000 or less 2. urban—population code greater than 5,000; and,
day/night	1. day—6:00 AM-9:00 PM 2. night—9:00 PM-6:00 AM

In general, Michigan State University (MSU) was responsible for the crash data while the University of Michigan's Transportation Research Institute (UMTRI) was responsible for exposure data. Both the accident and the travel data spanned the twelve-month study period beginning in May, 1987, and ending in April, 1988.

2. Truck Crashes in Michigan

In Michigan, all traffic crashes that occur on public roads are reported on a common form (UD-10, Traffic Accident Report) by the investigating officer. The data from the forms are then further interpreted (e.g., road classification codes) and entered in a computerized file which is maintained by the Michigan Department of State Police (MSP). These files are made available by both MSP and the Michigan Department of Transportation (MDOT). The MDOT has several versions of the file (e.g., one has physical location data) which are then available for researchers and others.

MSU was basically responsible for assembling and preparing the crash data for the study year. The preparation included a considerable manual effort because of significant coding errors which occurred when trucks were classified by type—involvement of singles was under-reported by approximately 20%. Manual review was also required to separate trucks registered in Michigan from those registered elsewhere, since this information is not included in the computerized files.

During the twelve-month study period there were approximately 21,900 crashes which involved a truck larger than a pickup or panel truck. Of these, just over 10,000 involved bobtails, singles, or doubles. Some of the findings regarding truck crashes in Michigan are summarized below. The findings noted here are based on crash frequencies and are not adjusted for exposure, as are crash rates. These frequencies indicate the sizes of different aspects of the truck crash problem, and how they compare with all traffic crashes. Findings based on crash rates, which identify configurations and operations with higher associated risks, are discussed later.

Overall

About 5% of all crashes in Michigan involve a truck larger than a pickup or panel truck. These accidents can be classified by the type of truck as follows.

Table 5-1
Distribution of Truck and All Crashes in Michigan

Truck Type	Crashes	Percent
Straight	10,993	2.7%
Bobtail	458	0.1%
Single	8,883	2.2%
Double	678	0.2%
All Trucks	21,827	5.3%
All Crashes	408,066	100%

Straight trucks (trucks with a cargo body mounted on the power unit chassis) are involved in about half of the truck crashes in Michigan. The other half are tractor configurations (bobtail, single, and double).

Types of Crashes

About 57% of non-truck-involved crashes involved two or more vehicles compared to 79% of all truck-involved crashes.

Other prevalent crash types appear to be most related to the type of service that the different truck types tend to provide: straights have turning, driveway, and angle-straight type crashes; singles have one-vehicle miscellaneous, two-vehicle turning, and (overall) two-vehicle crashes; and doubles have more overturning and other two-vehicle crashes (e.g., rear-end).

A far greater percentage of single-vehicle non-truck crashes occurred at night (about 50%) than did single-vehicle truck crashes (about 25%). Conversely, a higher percentage of truck-involved multi-vehicle crashes (46%) occurred during non-rush-hour daytime hours (9:00-3:00) than did non-truck-involved multi-vehicle crashes (32%).

Severity of Crashes

Trucks appear to be overrepresented in both fatal and property-damage-only crashes. While the absolute number of fatal crashes involving trucks is quite low (a total of 179 in 1988 for all types of trucks), the proportion of crashes that result in fatalities is about twice as high for trucks as it is for non-trucks. Crashes involving trucks appear to be more serious when the truck is vehicle-2 (the less at-fault vehicle) versus when it is vehicle-1 (the more at-fault vehicle).

Driver Age

In general, drivers of doubles are older than singles drivers, who are in turn older than the drivers of straights. (Note that this finding is based only on the ages of drivers who are involved in crashes.)

Roadway Type

In general, non-truck crashes were more likely to occur on the local road portions of the highway network (city streets and county roads) than were truck-involved crashes. For non-truck crashes, this is consistent regardless of severity level. For truck-involved crashes, however, fatals were somewhat more likely to occur on the non-local system (e.g., 40% of the fatals were on Interstate, and U.S.- and Michigan-numbered routes versus 33% of "B-injury" crashes).

3. Truck Travel in Michigan

In order to develop crash involvement rates, accurate exposure data (e.g., vehicle-miles of travel) as well as accurate crash frequencies are needed. Although MDOT collects vehicle count data at numerous counting stations, it is impossible to accurately disaggregate these data according to the variables cited above. Thus, new exposure data were collected by UMTRI in the Michigan Truck Trip Information Survey (MTTIS). The basic data came from telephone interviews of tractor owners (or their representatives) conducted during the study period. It should be noted that while the ultimate goal of the survey was to be able to estimate differential travel by truck type (i.e., bobtails, singles, and doubles), the unit of observation for the survey was the truck tractor (i.e., the power unit of a tractor-trailer combination). The travel estimate was then based on how that tractor was used; i.e., how much mileage, if any, was logged by the tractor without a trailer (as a bobtail), by the tractor pulling a single trailer (as a single), and finally by the tractor pulling two trailers (as a double).

The sample of owners for the MTTIS was drawn from the vehicle registration file maintained by the Michigan Department of State as of February, 1987. The target group consisted of the owners of truck tractors with an empty weight over 6,000 pounds—basically all medium- and heavy-duty truck tractors registered and operating in Michigan. The survey data were collected during four telephone interviews over the course of the study period: basic descriptive information on the company and the vehicle was obtained on the first interview, as well as actual travel information. The travel data consisted of information about loading, type of trailers, route covered, and other operational details. In all, travel information was collected on four randomly selected days spaced over the 12 month period for each of the sampled tractors. The route descriptions allowed mileage to be broken down by road type, time of day, and area type. Using this technique, travel estimates were generated for the three tractor configurations of interest for different combinations of road type, time of day, and area (urban-rural). In addition to travel characteristics, data were also obtained about the drivers (e.g., age and training). This methodology has been used successfully in the past in the context of the analysis of nationwide truck-involved fatal crashes.

The registration file indicated that there was a total of approximately 34,600 truck tractors registered in Michigan at the beginning of the study period, and detailed travel data were collected on a random sample of 1,085 of these. Findings concerning the travel patterns of trucks in Michigan are summarized below:

Travel Characteristics

It is estimated that Michigan-registered tractors traveled approximately 883 million miles within the state during the study period—an average of approximately 25,500 miles annually in Michigan.

It is estimated that 10,000 tractors in Michigan (just under 30%) are registered to gross over 80,000 pounds.

Tractors with semitrailers (singles) account for over 88% of the total travel with doubles accounting for 10.4% and bobtails just 1.2%.

Approximately one-half of the travel by singles is on limited access highways during the day (27% rural, 23% urban) and almost another 25% is on major highways during the day (17% rural, 8% urban). The highest percentage of night travel (by highway and area type) is on limited access highways in rural areas (5.5%). Overall, about 59% of the singles travel was on limited access roadways.

The distribution of travel by doubles is very similar to that of singles, with the principal exception that about 11% of doubles travel is on limited access highways in rural areas at night. Overall, doubles traveled on limited access highways about 64% of the time—about 5% more than the comparable figure for singles.

A consideration of the travel of all tractors broken down by the approximate gross combination weight of the vehicle indicates that the 20-40,000 pound group (virtually all empty, or nearly empty, singles) accounts for about 39% of all travel, the 40-80,000 pound group accounts for about 43%, and about 14% of all travel is at weights in excess of 80,000 pounds.

For singles, nearly 44% of the travel is while empty or very lightly loaded while about 20% is in the 40-60,000 and 60-80,000 ranges (each) and about 10% occurs at weights over 80,000 pounds.

For doubles, the distribution of travel by weight is somewhat different. About 43% of the travel is while empty. The percentages are lower for intermediate weights, rising gradually to 26% in the 140-160,000 pound range. This indicates that doubles are very likely to be running fully loaded in one direction and returning empty—a typical pattern for the commodities carried by the very heavy trucks (e.g., gravel).

Driver Characteristics

The distribution of driver age shows that only 3.5% of the drivers are 24 or younger, while about 14% are 25-29, and 18% are 30-34. The percentages then drop gradually until 50-54 which accounts for 10.5%, and then more abruptly as only 6% are 55-59, about 2% are 60-64 and less than 0.5% are over 64.

With driver "training" defined as a combination of classroom and on-the-road training, approximately 54% of the drivers had no such training. Only about 15% had such training—the remainder, about 31%, were unknown. (The drivers themselves could not always be interviewed, and this information was often unknown to the actual interviewees.)

Of the drivers who had training (15%), about two-thirds received it from the employer (either current or previous), truck-driving schools accounted for about 18%, and the military for less than 10%. In other words, less than 3% of all drivers surveyed had received training at a truck driving school. For-hire haulers and companies that operate in interstate commerce may have a higher proportion of trained drivers, but the large amount of missing data makes firm conclusions on that score impossible.

4. Truck Crash Rates Michigan

The crash involvement and exposure data were combined to produce differential truck crash rates for various combinations of the stratifying variables described above. Remember that the exposure survey covered only travel in Michigan by tractors registered in Michigan. Thus, only crash involvements of Michigan-registered tractors were used for the rate calculations. About 62% of the tractors involved in crashes in Michigan were registered in Michigan.

In addition to the rates based on all combinations of these variables, rates based on only casualty crash involvements, or property-damage-only crash involvements were also calculated. The calculated rates for all police-reported, Michigan-registered tractor crash involvements, in their most disaggregate form, are shown in table 5-2 (this is a repeat of table E-1 in Appendix E). The rates are presented as crash involvements per million miles traveled.

Table 5-2
Overall Tractor Crash Rates
(all involvements)
Michigan-Registered Tractors on Michigan Roads

Travel Category			Bobtail		Single		Double	
			Crashes	Rate	Crashes	Rate	Crashes	Rate
Rural	Day	Limited	17	8.1	768	3.8	86	3.7
Rural	Day	Major	41	19.5	971	7.5	112	7.4
Rural	Day	Other	69	265.4	948	29.8	86	26.8
Rural	Night	Limited	9	37.5	200	4.8	25	2.6
Rural	Night	Major	8	114.3	182	10.3	17	7.1
Rural	Night	Other	14	233.3	89	69.0	6	27.3
Urban	Day	Limited	40	15.2	455	2.6	66	3.1
Urban	Day	Major	36	38.7	445	7.4	41	7.4
Urban	Day	Other	65	45.1	926	15.5	53	10.7
Urban	Night	Limited	4	10.8	63	2.1	4	1.2
Urban	Night	Major	0	0.0	64	9.4	5	10.9
Urban	Night	Other	11	122.2	68	18.0	8	23.5
Total			314	30.3	5,179	6.8	509	5.7

While some of the rates in this table should be interpreted with care given that the sample sizes are small, the results from table 5-2 (and related analysis not shown here) can be summarized:

In virtually all instances, bobtail crash involvement rates are far higher than those for singles and doubles.

Rates for doubles are generally somewhat lower than those for singles. It should be noted that this is the case regardless of whether all, one-vehicle, or multi-vehicle crashes are considered although the breakdown by number of vehicles involved is not shown in table 5-2. The same differential holds regardless of whether the truck in the crash was noted as vehicle-1 (the more-at-fault vehicle in the crash) or vehicle-2 (the less-, or not-at-fault vehicle) in the crash.

Although there are just over 300 bobtail involvements, the highest rates tend to be at night, generally in rural areas, and, most clearly, on the lowest class of roadway.

Singles involvement rates are always higher for lower classes of roadways—rates for major highways are typically two to three times higher than for limited access highways; and rates for other highways are typically seven to ten times higher than for limited access highways.

Singles involvement rates for night conditions are, at worst, about twice as high as for daytime conditions—typically for rural, other roads. The difference between night and day is not as distinct for urban areas. Generally, urban rates are lower than rural rates regardless of roadway class.

The results noted for singles are reasonably consistent regardless of whether the involvement is as vehicle-1 or vehicle-2.

Although limited by sample size considerations, doubles rates are lower than singles in most instances—the principal exception (from table 5-2) is on urban, limited access roads during the day.

Further analysis indicated that doubles rates were higher than singles in some specific situations such as: for one-vehicle involvements, rural limited access highways during the day; and for multi-vehicle involvements, rural major roadways during the day and urban limited access roadways during the day. It is interesting to note that the higher one-vehicle crash rate is primarily due to rollover crashes, a crash type for which doubles are well-known.

Table 5-3
Overall Tractor Casualty Crash Rates
(all involvements)
Michigan Tractors on Michigan Roads

Travel Category			Bobtail Crashes	Bobtail Rate	Single Crashes	Single Rate	Double Crashes	Double Rate
Rural	Day	Limited	7	3.3	188	0.9	21	0.9
Rural	Day	Major	12	5.7	241	1.9	31	2.1
Rural	Day	Other	22	84.6	200	6.3	26	8.1
Rural	Night	Limited	2	8.3	63	1.5	11	1.2
Rural	Night	Major	0	0.0	61	3.5	5	2.1
Rural	Night	Other	7	116.7	22	17.1	2	9.1
Urban	Day	Limited	9	3.4	107	0.6	13	0.6
Urban	Day	Major	4	4.3	92	1.5	11	2.0
Urban	Day	Other	7	4.9	118	2.0	17	3.4
Urban	Night	Limited	0	0.0	23	0.8	1	0.3
Urban	Night	Major	0	0.0	19	2.8	0	0.0
Urban	Night	Other	4	44.4	19	5.0	6	17.6
Total			74	7.1	1,153	1.5	144	1.6

Rates considering only casualty crashes are shown in table 5-3. The results shown in this table (which repeats table E-2 in the Appendix E) and from related analysis (not shown here) can also be summarized:

> Although there is an even greater scarcity of bobtail data, bobtail rates are higher than those for either singles or doubles. The ratio of the rates is about the same as it was when all (casualty and non-casualty) crashes were considered. In contrast to the set of all crashes, when only casualty crashes are examined, the overall doubles rate is higher than the singles rate. More specifically, it appears that doubles rates are higher than singles for day conditions in both rural and urban situations, and regardless of roadway class. Sample sizes for the disaggregated rates are, however, very small.
>
> When a differentiation between involvement as vehicle-1 and vehicle-2 was made, both singles and doubles have higher rates as vehicle-2 (vs. involvement as vehicle-1) in casualty crashes than they did for all crashes; and doubles have a lower involvement rate as vehicle-1 than singles (in casualty crashes).

While the disaggregated casualty crash rates shown in table 5-3 are of considerable interest, the sample sizes are, as noted, quite small in some instances. However, the crash and travel data can also be aggregated by the key variables and yield rates such as daytime rates for different truck types regardless of roadway class and urban/rural classification. The results of calculating such aggregated rates are given below in summary form. All rates are given in crashes per million vehicle-miles.

Table 5-4
All and Casualty Crash Rates
by Truck Configuration

	all crashes	casualty crashes
bobtails:	30.30	7.15
singles:	6.79	1.51
doubles:	5.69	1.61
total:	6.96	1.59

The above rates serve to highlight the fundamental differences between the different types of trucks and the impact of including property-damage-only (PDO) crashes in the rate calculation. The bobtail rates are clearly far higher than those for combination trucks, and inclusion of the PDO crashes tends to "wash out" some of the differences between truck types. When PDOs are included, the singles rate is considerably higher than the doubles rate—however, when only casualty crashes are considered, the differences between singles and doubles are very small.

Table 5-5
All and Casualty Crash Rates
by Truck Configuration and Urban/Rural Area

	all crashes		casualty crashes	
	urban	rural	urban	rural
bobtails:	28.21	32.71	4.34	10.35
singles:	5.99	7.42	1.12	1.82
doubles:	4.93	6.21	1.34	1.79
total:	6.22	7.54	1.19	1.90

The aggregation of urban and rural rates (regardless of roadway type and time of day) shows that, in general, rural rates are higher than those in urban areas (regardless of truck type and whether PDOs are considered). Furthermore, in both urban and rural areas the bobtails rates are still far higher than combination trucks. The rates for singles and doubles are very similar to each other although both have higher rural rates. The ratio of rural to urban rates is greater when only casualty crashes are considered (for both singles and doubles). It should also be noted that as PDO crashes tend to "drive" the overall rates, singles crashes also tend to dominate when, for example, the total rate is considered.

Table 5-6
All and Casualty Crash Rates
by Truck Configuration and Time of Day

	all crashes		casualty crashes	
	day	night	day	night
bobtails:	28.33	51.11	6.45	14.44
singles:	6.82	6.57	1.43	2.04
doubles:	6.08	3.97	1.63	1.53
total:	7.02	6.55	1.51	2.07

The differences between day and night rates are somewhat less clear than the other aggregated rates considered to this point. Overall, when all crashes are considered, the night rates are lower than the day rates, although this is not the case for bobtails. For combination trucks, there is more of a difference for doubles than for singles—i.e., the night doubles rate is much lower than the day rate. However, when only casualty crashes are considered, the night rates are higher for both bobtails and singles. The doubles rate is still somewhat lower at night than during the day. The "total" rate shows that when only casualty crashes are considered, combination trucks tend to have higher night rates—this is, however, driven by bobtails and singles.

Table 5-7
All and Casualty Crash Rates
by Truck Configuration and Road Type

	all crashes			casualty crashes		
	limited	major	other	limited	major	other
bobtails:	13.11	26.81	85.95	3.37	5.05	21.62
singles:	3.28	7.80	21.03	0.84	1.94	3.72
doubles:	3.16	7.47	17.55	0.80	2.01	5.85
total:	3.37	8.02	21.87	0.86	1.99	4.20

The aggregated rates by roadway type show a clear and consistent trend: the lower the road class, the higher the crash rate, regardless of truck type or whether all crashes or only casualty crashes are considered. The similarity between the rates for singles and doubles should also be noted although there is some divergence between the two when the lowest road class is considered.

5. Principal Findings and General Conclusions

As with any study of this magnitude, there is a host of sometimes confusing and/or contradictory results. However, it may be argued that there are several dominant findings that resulted from the project, notwithstanding some relatively minor variations. With regard to the three truck types that were considered,

- the bobtail configuration clearly has the most serious problem safely negotiating the highway system; and

- the performance of single and double truck configurations are generally quite similar to one another in terms of overall safety on the highway system.

In addition to the differences (or lack of them) that are attributable to truck type, there are also effects that are due to differences in the truck operating environment. In this study, environmental effects were limited to the type of roadway, the time of day, and whether the trucks were operating in rural or urban areas. The principal effects that were attributed to variation in these parameters are:

- the most significant and consistent effect appeared to be due to the type of roadway since crash rates for all types of trucks were highest on other roadways and lowest on limited access highways (generally regardless of variation of other variables);

- crash rates were generally lower in urban areas than they were in rural areas, regardless of truck type;

- at more aggregated levels, nighttime crash rates were lower than daytime rates for combination trucks (although the differential was greater for doubles) but higher for bobtails; overall, casualty rates were higher at night;

- there was some evidence of interaction among environmental variables, especially when the day and night rates were considered, that affected singles rates (i.e., several singles rates were higher at night).

- drivers under age 25 or over 60 were over-involved in crashes; the highest risk was shown for drivers aged 19-20, who were over-involved by a factor of 5.

Some of the findings reported above confirm earlier work. Of greater importance, however, is the general finding that the crash rates for singles and doubles are not radically different from one another, though part of the reason that doubles have relatively low crash rates is that most of their travel is on limited access roads, the safest in the highway system. It was also found that the other factors that appear to affect the relative safety of one type of truck have similar effects on the others as well. This is especially interesting since Michigan has liberal truck weight regulations and considerable experience with doubles on the highways. This is not to say that there are not specific instances when doubles do not perform as well as singles, but that in general they appear to present a similar degree of risk.

Perhaps the most significant and somewhat unexpected finding was the degree of degradation of relative truck safety when lower classes of roadway were considered: the crash rates on the lowest class of roadway were five to seven times higher than those on the limited access system. This far overshadows the effects of truck type or any of the other environmental factors.

6. Implications for Truck Crash Countermeasures, Highway Safety Policy, and Future Work in Michigan

The implications for truck crash countermeasures, highway safety policy, and future work in Michigan are varied. Given that the work just completed provides an accurate overview of the truck safety problem in Michigan, the most important implications for the future are the need for more specificity in future work and the need to move forward in developing, implementing, and evaluating countermeasures.

Improvements in Crash Data

In order to move forward with work in truck safety in Michigan, one of the key areas needing attention is data collection. Although the crash data available in Michigan are among the best in the nation, there are some shortcomings which were highlighted during this study. Specifically in regard to trucks, the data are inadequate in terms of describing the vehicle itself—truck tractor and trailer descriptions lack specificity (e.g., trailer type, tractor description, length and width, number of axles). Perhaps even more importantly (and of concern beyond just trucks) is the need to be able to effectively and efficiently merge data from the various files that are maintained by the state—e.g., crash data, vehicle registration data, and driver information.

The proposed Michigan Supplemental Truck and Bus Traffic Accident Report promises to remedy some of these problems by providing additional information on operating authority, gross vehicle weight rating, vehicle configuration, and cargo body type. Vehicle combination weight, length, width, and number of axles are not included on the form. The amount of detail on the physical characteristics of the truck that the supplemental report will provide is minimal, but it is an important first step toward capturing more complete information.

This study uncovered some evidence that suggests very few of the truckers on Michigan roads have had any driver training. Currently, there is no accident data on the driver training of truckers involved in crashes, though with the Commercial Driver License program and the growing emphasis on driver training, there will be a need to evaluate the safety impact of driver training schools.

As it stands at this point, the current data cannot be used to evaluate other key issues that have come up in the last several years—for example, it is virtually impossible to assess the impact of longer and/or wider trucks on Michigan's highways. Issues related to carrier type, e.g., examining the safety experience of inter- versus intrastate carriers, cannot be undertaken using currently available data. Further, it would be difficult, if not impossible, to differentiate the effect of increased numbers of doubles operating on Michigan roadways as a result of the 1982 Surface Transportation Assistance Act (STAA) from the pre-STAA doubles that were already allowed in Michigan.

Improvements in Truck Exposure Data

The exposure data gathered by UMTRI for this study are unique for the state and for a specific time period. Beyond these data, currently there are no viable truck exposure data being collected in Michigan that can be used for anything more than the grossest statewide analysis. If further rate-based work is to be done on truck safety in Michigan, particularly given the dynamic nature of the trucking industry, a methodical data collection plan needs to be implemented which will permit the calculation of vehicle miles of truck travel differentiated by truck type, roadway class, and selected other environmental variables. These data should include all trucks using Michigan roads.

Further Work on the Relationship between Truck Crashes and Geometry

One of the original objectives for the current project had been exploration of the relationship between roadway geometry and truck type. As noted earlier, as the project progressed, problems with data reduction acted to curtail the scope of what was studied. This project has, however, confirmed that restrictive geometry (as measured by which class of road is being considered) is a serious problem in truck safety. In fact, examination of some crashes showed that even the low crash rates for limited access highways may be overstated. For example, it was shown that a sizable number of one-vehicle crashes involving doubles resulted from overturns on ramps.

More work is required which is addressed to identifying those geometric characteristics which are specifically related to truck crashes. This should include not only consideration of the characteristics of the crashes and the roadways but also truck loading and travel characteristics. For example, the crash potential on ramps is related not only to the interaction between truck type per se and ramp geometry but also to the specifics of the truck configurations and their loads.

7. Conclusion

The work on the travel and safety of Michigan trucks presented in this report has covered considerable ground. The survey has determined the number of Michigan trucks and how they are distributed by licensed weight and the type of company which operates them. Travel information at a level of detail unavailable elsewhere has been collected and analyzed. The work also included a survey of the men and women who drive the trucks included in the study, to determine their level of training. Moreover, the Michigan crash experience of trucks spanning nearly a decade has been examined and compared to the rest of the motor vehicle population. Some problems in the collection and coding of that data have been identified. The study also presented data which speak to the role of the truck in motor vehicle crashes, and the size and seriousness of the truck safety problem, compared to other vehicles on the road.

But the main product of this study, the focus of the work, has been on the factors which affect the probability of crash involvement for Michigan tractors. For this, a substantial framework which can support future work has been constructed. By calculating and comparing crash rates in different circumstances, the role of the different tractor configurations has been clearly delineated. The bobtail configuration, a tractor without a trailer, has the highest crash rate of any configuration, sometimes several times higher. Overall, singles are similar to doubles, though there are differences between road types. Road type itself has been shown to have a large impact on crash rates. Some types of roads are much safer to operate on than others. The interstate highway system and other roads built to that standard are clearly the safest, while the U.S.- and State-numbered routes have crash rates about twice as high, and the remainder of the road system has rates nearly seven times as high. The more complicated impact of nighttime operations has also been explored. Casualty crash rates were higher at night, but PDO rates were higher during the day, when traffic densities are higher. And despite the fact that urban areas typically have higher traffic densities, rural areas generally had higher involvement rates than urban areas.

While this study has been comprehensive, by no means has it been exhaustive. Many questions remain. The analysis can be extended in several productive directions. The impact of carrier type, gross vehicle weight, and trailer cargo body are all opportunities for further research. Limitations in the information available from the UD-10, Traffic Accident Report, prevented this study from investigating carrier type, particular types of cargo bodies, or the impact of gross vehicle weight on the probability and seriousness of a crash. In an era of deregulation, differences in the safety record of various categories of truck operators will be of increasing interest, as well as an evaluation of any safety benefit from driver training schools. There is also considerable interest state wide in such combinations as Michigan gravel trains, not only in terms of load spillage, but also given the great weights at which these vehicles operate. The crash rates of tank trailers, particularly doubles, should also be examined—for example, the association between gross weight, road type, and rollover is an important safety issue.

Dealing with these issues requires additional data. Information on, for example, the cargo body, gross weight, and carrier type of trucks involved in crashes would have to be assembled. There may be some further work necessary as well to keep current with the changing trucking industry and to extend the analysis to all trucks operating on Michigan roads. But the necessary research techniques and methodologies have been established and demonstrated, in part by the present study. Moreover, by detailing the structure of trucking in Michigan and by identifying major factors affecting truck safety, the work represented by this report has laid a firm foundation that can support the exploration of future truck safety issues.