Highway Fatality Rate Reductions in ITE Western District States

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Abstract
In the year the Federal Highway Safety Act of 1966 (*1*) was passed, nearly 51,000 road users were killed on US highways and the highway fatality rate was 5.50 fatalities per 100 million vehicle miles (100 mvm). In 1991, annual highway fatalities had dropped by 10,000 and the rate had decreased to 1.91 fatalities per 100 mvm. By 2010, nationwide highway fatalities fell to less than 33,000 and the rate was 1.09 per 100 mvm; if last year's rate had been the 1966 rate, more than 165,000 persons would have died on our highways.

This paper examines changes over recent years in the highway fatality rates in the thirteen states in ITE's Western District. In 1995, the nationwide highway fatality rate was 1.73; only four states in the West (CA, HI, UT, and WA) had lower rates. By 2010, the nationwide fatality rate had dropped to 1.09, but six western states (CA, CO, HI, OR, UT, and WA) had lower rates. This improvement occurred even though eight of the western states have rural, passenger vehicle Interstate speed limits of 75 mph and large expanses of rural area, far removed from emergency services. This paper also evaluates the relationship between highway fatality rates and state population.

Background
On the evening of September 13, 1899, Henry Bliss, a New York real estate man, disembarked from a streetcar at West 74th Street and Central Park West in New York City, where he was struck and knocked unconscious by an electric-powered taxicab. Bliss died the following morning, reportedly becoming the first highway fatality in the United States, and indeed, in the western hemisphere(*2*). Arnold Smith, the taxicab driver, was arrested and charged with manslaughter but was acquitted on the grounds that it was unintentional. A plaque was dedicated at this site on September 13, 1999, to commemorate the centennial of this event.

Since Mr. Bliss's demise, more persons have died on US highways than have perished in all the wars that the country has fought. For comparison purposes, the US military death toll in the Vietnam conflict from 1956 to the present is 58,269 (*3*), only 10% higher than the 1972 US highway fatality count of 54,589, just prior to the introduction of the national maximum speed limit of 55 mph.

Although nationwide highway fatality statistics from the early 1900s are incomplete, there is a general consensus that deaths of motorists, pedestrians, and other road users generally increased annually from Mr. Bliss's death until 1972, with the exception of the years of World War II and its aftermath, the latter downturn due to gas rationing, wartime speed limits, and economic constraints. By 1921, which predated the creation of the US Department of Transportation by 45 years, annual nationwide highway fatalities had increased to (approximately) 13,000. The national leader at that time with the closest relationship to highway safety was Secretary of Commerce Herbert Hoover. In 1923, Hoover convened the First National Conference on Street and Highway Safety for the purpose of deciding what the federal government could do to help

improve safety on US highways. In addressing the Conference, Hoover said “There is no uniformity in traffic regulations. I could be arrested and convicted on a dozen counts by driving between Washington and New York if I carefully followed either the Washington or New York traffic regulations (on my trip).” Perhaps not surprising in hindsight, the Conference recommended that all drivers should be licensed and that there be a uniform set of traffic laws, which led to the creation of the (now defunct) Uniform Vehicle Code in 1926.

In 1930, there were 26.5 million registered vehicles in the United States; during that same year, approximately 33,000 persons died in motor vehicle crashes at a staggering rate of 17.75 fatalities per 100 million vehicle-miles (fatalities/100 mvm). As noted earlier, fatalities peaked in 1972, but due to improvements in vehicles and highways (and possibly road users), the fatality rate had dropped dramatically, to 4.33 fatalities/100 mvm. Since 1972, highway fatalities have been affected by economic conditions, fuel costs, safer designs for vehicles and highways, and similar factors. However, fatality rates have shown a nearly continual decrease to an unprecedented low of 1.09 fatalities/100 mvm in 2010. The change in nationwide motor vehicle fatalities and fatality rates over the period 1930 through 1980 are depicted in Figure 1.
The figure shows a dramatic improvement. The Highway Safety Act of 1966, its companion

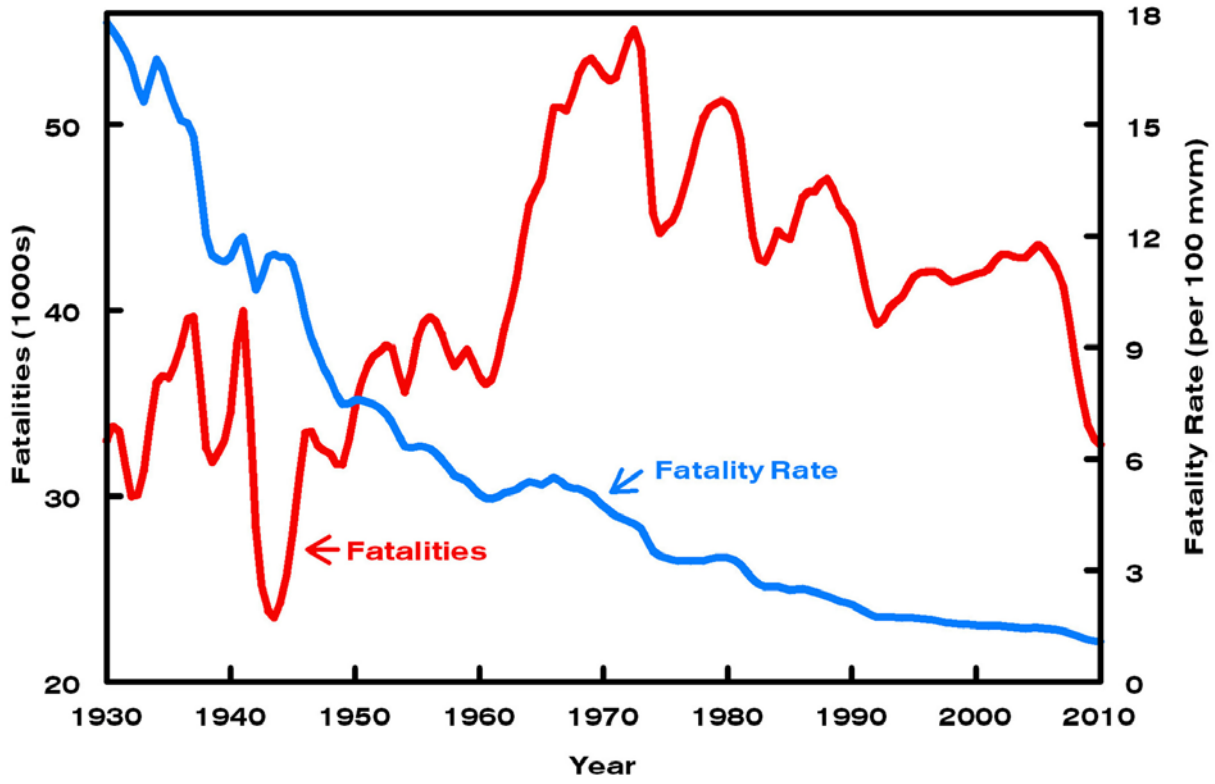

Figure 1 US Highway Fatalities and Fatality Rates 1930-2010

Motor Vehicle Act of the same year, the creation of the National Highway Safety Bureau (now the National Highway Traffic Safety Administration, NHTSA), increased congressional oversight of highway safety, the publication of the AASHTO *Yellow Book* (4), and similar initiatives are primarily responsible for the improvements in fatalities and fatality rates. However, the reductions have not been uniform for all types of crashes. Between 1975, when

there were 44,525 fatalities, and 2010, when there were 32,788 fatalities, nationwide highway fatalities decreased by 26 percent. Due to increased travel, the fatality rate decreased by 67 percent. Perhaps the most dramatic fatality change between 1975 and 2010 involved crashes between highway and railway vehicles, which decreased 76 percent from 888 to 217. A smaller but significant reduction occurred for pedestrian fatalities, which dropped 50 percent from 8,600 to 4,280. A different trend was found for motorcycle fatalities; from 3,189 in 1975, they dropped to a low of 2,116 in 1997, but rose to 4,502 in 2010.(5) NHTSA reports that the increase is primarily attributable to motorcyclists over the age of 50.

Highway Fatalities in ITE's Western District

With the dramatic improvement in nationwide highway fatality numbers and rates documented above, it is certainly appropriate to assess how well the 13 states that comprise the Western District of ITE have fared in comparison. At the broadest level, one can compare the proportion of all US highway fatalities that are in ITE's Western District. To moderate year-to-year variations in highway fatalities, the initial analysis compares the average number of highway fatalities in two-year intervals; the results are presented in Table 1.(*6*) As shown by the table, the west's share of the country's highway fatalities has decreased in recent years. But these promising findings are tempered by other factors, such as changes in travel, population, traffic enforcement, emergency medical services, and similar factors.

Table 1	Highway Fatalities/yr		
Years	Western District	United States	West/US (%)
1995-96	8,954	41,941	21.3
1997-98	8,400	41,757	20.1
1999-2000	8,439	41,831	20.2
2001-02	8,995	42,601	21.1
2003-04	9,116	42,860	21.3
2005-06	9,351	43,109	21.7
2007-08	8,126	39,341	20.7
2009-10	6,543	33,347	19.6

A more useful analysis of highway fatalities would consider the annual fatality rates, which are based on both the number of fatalities and the amount of vehicle travel. Using data provided by the states from their Highway Performance Monitoring Systems, the Federal Highway Administration (FHWA) estimates the annual vehicle-miles of travel for each state; the results are reported by roadway classification in FHWA's annual report Highway Statistics. The travel, coupled with the number of highway fatalities, were used to estimate the highway fatality rate by year for each of the 13 states in ITE's Western District. Table 2 shows the average rate for 1995-2010, together with the highest and lowest fatality rates over this 16-year period.(*6*)

Table 2		Highest		Lowest	
State	Average	Rate	Year	Rate	Year
Alaska	1.70	2.11	1995	1.17	2010
Arizona	1.95	2.61	1995	1.27	2010
California	1.22	1.52	1995	0.84	2010
Colorado	1.41	1.84	1995	0.95	2010
Hawaii	1.41	1.84	1996	1.04	2008
Idaho	1.81	2.13	1995	1.32	2010
Montana	2.28	2.82	1997	1.69	2010
Nevada	1.85	2.24	1995	1.19	2009
New Mexico	1.87	2.29	1995	1.37	2010
Oregon	1.38	1.91	1995	0.94	2010
Utah	1.31	1.79	1997	0.89	2010
Washington	1.13	1.44	1996	0.80	2010
Wyoming	1.88	2.41	1995	1.40	2009

Several facts are clear from the table. All of the years with the highest fatality are between 1995 and 1997; the highest rate was in 1995 for 9 of the states. Likewise, all of the years with the lowest rates were between 2008 and 2010; in 10 states, the lowest fatality rate was in 2010. The ratio of the lowest to the highest fatality rate ranged from 0.49 (in both Arizona and Oregon) to 0.62 (in Idaho); the average ratio among all the western states was 0.55. Despite the wide open spaces throughout much of this district, it is encouraging that the lowest rates in six states (CA, CO, HI, OR, UT, WA) fall below the national highway fatality rate of 1.09 fatalities/100 mvm.

A casual review of the fatality data suggests that the highway fatality rates are higher in states that have lower populations and more rural area, while they are lower in the more populous states with more urban areas. To test this theory, state populations from were obtained from the 2010 census. The most obvious problem was the large variation in populations, where California's population (37.55 million) is 66 times larger than Wyoming's. The common method for treating such a wide variation in variable size is to perform a transformation to reduce the variation by taking the square root or the logarithm of the variable. For this analysis, the logarithms to the base 10 were calculated for the populations, reducing the variables to the range 5.76 to 7.58. To reduce the effect of year-to-year variations in highway fatality rates, the average rate for each state for the two-year period 2009-2010 was calculated. Figure 2 shows the scatter plot of highway fatality rate as a function of log of state population, along with the best fit regression line.

The correlation coefficient between the highway fatality rate for 2009-2010 and the logarithm of the state's population in the 2010 census is 0.66. The R^2 is 0.43, which means that 43% of the variation in the fatality rate is explained by the change in the log of the population. The correlation is statistically significant, but is clear that other factors not considered in this simplified analysis also affect the fatality rate.

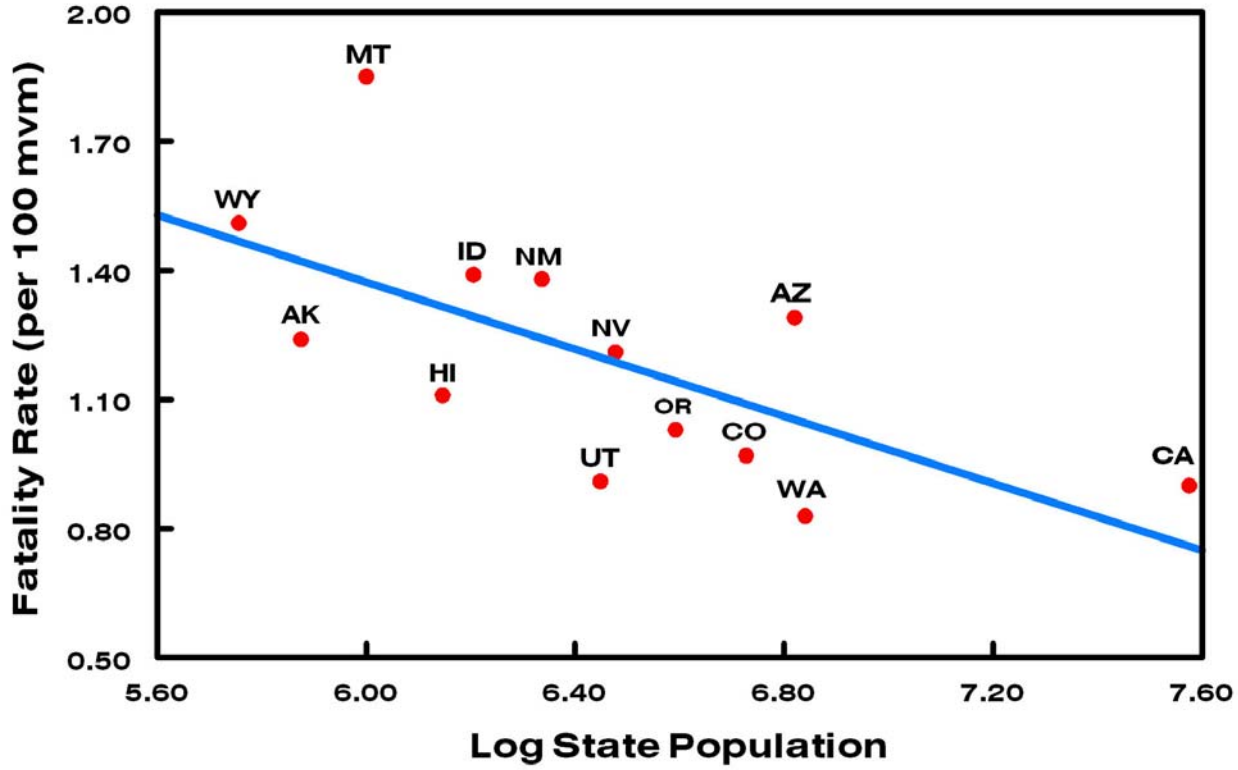

Figure 2 Western District 2009-2010 Highway Fatality Rate versus Log of State 2010 Population

The best fit line shown in figure 2 is given by:

$$Fatality\ Rate = 3.7175 - 0.3905 \times Log_{10}\ State\ Population$$

But because $10^{3.7175} = 5218.45$, the relationship my be rewritten as:

$$10^{Fatality\ Rate} = 5218.41 \times (State\ Population)^{-0.3905}$$

Summary and Conclusions

This evaluation has found that nationwide highway fatalities have decreased to their lowest level since 1949. As shown in Figure 1, the highway fatality rate has decreased year-to-year for 66 of the past 84. In fact, there were only six years (1934, 1941, 1943, 1962, 1964, and 1966) when the increase in the highway fatality rate exceeded 0.10 fatality/100 mvm. The percentage of nationwide highway fatalities that occur in states of ITE's Western District has tended to decrease over the past 16 years; as shown in Table 2, it is currently below 20%. An analysis of annual highway fatalities by state over the past 16 years found that fatalities are decreasing in all of the states. Rates over the study period ranged from 1.13 fatalities/100 mvm in Washington to

2.28 in Montana. The lowest rates in recent years have also been in Washington (0.80) and Montana (1.69), indicating a significant improvement among all states. Nearly half the states in ITE's Western District have highway fatality rates below the national average, a somewhat surprising finding given the rural nature of most of the western states.

The final analysis sought to find a relationship between recent state highway fatality rates and population. As noted above, highway fatality rates among the western states vary only by a factor of 2, while the highest population state has over 60 times the population of the smallest. To overcome this constraint, the regression analysis evaluated the highway fatality rates as a function of the logarithm of state population. The results, shown in Figure 2, found a best fit equation that is statistically significant. It overestimates the highway fatality rates in six states, and underestimates the rate in six states; in one state, the observed and predicted rates are within 0.02 fatalities/100 mvm.

Figure 1 showed the reflected the nationwide decrease in the frequency and rate of highway fatalities. Table 2 demonstrated that highway fatality rates are decreasing in all of the western states. The challenge for highway/traffic engineers, vehicle designers, and others responsible for highway safety is how to continue reducing fatality counts and rates. Continuing challenges, such as speeding and impaired driving, and more recent challenges, often grouped under the title of *distracted driving*, pose serious hurdles for safety professionals. Engineers need to continue exploring new technologies that can overcome factors working counter to highway safety.

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