Safe highways of the future

Sylvia Brewda analyzes the relationship between highway fatality rates and population density, use of motor vehicles, and quality of transportation infrastructure. Part 3 in a series.

As part of our continuing study of transportation, in this report we are looking at the issue of safety. Factors determining transportation safety are examined for the United States, in comparison with Western European nations and Japan. Since highway traffic is the most dangerous mode of transport, and the most heavily used for personal travel, transportation safety is defined by the effective provision of alternate modes of transport, and the actions taken to improve safety.

Considering the present heavy use of motor vehicles, and the increases in their use which we would wish in the developing sector, even with increase of mass transit, it is useful to examine the U.S. record in highway safety. There has been a general trend toward a decrease in the death rate throughout the advanced sector. This is directly coupled with improvements in highway design; however, as the leveling off of accident reduction in New Zealand shows, this is by no means an automatic tendency. Unless significant progress is made in understanding and preventing highway accidents, industrializing countries will be facing death-tolls in the hundreds of thousands as they build up their transportation capabilities.

More people under the age of 40 die as a result of highway accidents, in the United States, than from any other cause (**Figure 1**). In absolute figures, highways deaths in the United States are the highest in the world, seven times those of Korea, and four times those of the Federal Republic of Germany (**Figure 2**). While the death rate per capita as a result of highway accidents is also relatively high in the United States, this reflects the far greater use of highways. To focus on the per-capita death rate, would be to ignore the valuable function of the personal automobile in the economy. Instead, we will consider death rates as a function of the use of the transportation system, expressed in two different ways. The first focuses on the economic activity accomplished: death rate per *passenger*-mile or per *ton*-mile of freight movement. As we shall see, transportation safety can be decisively altered by changes in the mode by which people and freight are moved. The other method is to look at highway death rates per *vehicle*-mile. This concentrates attention on the safety of the highways themselves, the vehicles and the drivers, at a given intensity of highway use. In terms of this second measure, the United States has the best driving safety record in the world. In rank order, the United States is followed by Great Britain, with West Germany having double the accident rate per vehicle-mile, and South Korea at the bottom of the list with a rate 50 times greater.

Thus from the point of view of traffic on highways, the United States does not fare poorly—a fact emphasized by the decreasing trend in highway fatalities since the early part of the century. On the other hand, when we consider the waste of human life, it becomes clear that alternate modes of mass transit, such as the fast and efficient magnetically levitated passenger trains (see *EIR*, Jan. 24, 1986, "Opening the age of magnetic flight"), are a preferable alternative to long-trip use of passenger cars.

U.S. transport requirements

Any competent discussion of highway safety must locate it as a characteristic of the overall transportation system, a fundamental aspect of the national economy. This system encompasses highways, railroad track, waterways used by commercial shipping, and airports, as well as the vehicles which operate on them. In some poorer countries, bicycles are a part of the transportation system. Stop-signs, traffic lights, railroad crossing gates, even sidewalks are part of the transportation system.

FIGURE 1
Highway safety in the United States

Deaths from motor-vehicle accidents (1984)	46,200
Deaths per 1 million population	196
Deaths per 1 million registered vehicles	265
Deaths per 1 million licensed drivers	294
Deaths per 1 billion vehicle-miles	26.8

U.S. deaths by age group (1982)

Age	Cause*	Number	Rate per million pop. of that age
0-4			
	Total	50,311	2,911
	Motor vehicles	1,300	75
	Perinatal conditions	20,685	1,197
5-14			
	Total	9,625	282
	Motor vehicles	2,301	67
	Cancer	1,401	41
15-24			
	Total	41,971	1,013
	Motor vehicles	15,324	370
	Homicide	5,602	135
25-44			
	Total	107,615	1,594
	Motor vehicles	14,469	214
	Cancer	18,169	269
45-66			
	Total	410,103	9,205
	Motor vehicles	6,879	154
	Heart disease	141,567	3,177
65 and over			
	Total	1,355,172	49,706
	Motor vehicles	5,506	205
	Heart disease	596,800	22,218

*Third cause shown is highest for that age group, or second following motor-vehicle accidents, if that is the highest.

FIGURE 2
Comparative death rates

	Number of deaths	Per million persons	Per billion vehicle-miles
United States	45,799	199	27.2
Great Britain	5,934	106	35.2
Netherlands	1,710	122	36.8
Australia	3,252	214	41.6
Japan	11,795	100	47.8
Italy	8,400	147	48.0
New Zealand	674	213	56.0
Fed. Rep. Germany	11,608	187	56.0
France	12,856	238	59.2
Venezuela	5,353	364	86.4
Spain	5,719	150	94.4
Bolivia	629	106	96.0
Portugal	2,809	279	156.0
Turkey	5,893	127	291.0
Thailand	3,091	64	240.0
Kenya	1,462	82	432.0
S. Korea	6,110	105	1,008.0

The transportation system of the United States had one intrinsic problem to overcome: the large size and relative underpopulation of the American continent, compounded by the general lack of navigable rivers in the western section of the country. With the failure to implement ambitious water development projects, of the scope of the North American Water and Power Alliance (Nawapa), which would have diverted Canadian water over the Rockies, ultimately into the Mississippi River, the United States has not maintained an adequate system for internal communication of freight by waterways. Indeed, under the policy of deindustrialization which now underlies government economic planning, major ports such as that of Chicago are falling into disuse, while water-front property in the Baltimore port district is transformed to house a convention center. Within these parameters, the United States has developed a relatively high reliance on air travel for personal transportation, and on a combination of rail and water for freight transport (**Figure 3**).

While the U.S. level of per-capita passenger-miles is the highest in the world, if we compare the amount of transportation activity per capita and the relative weights of transport modes of passengers in a sampling of advanced-sector countries, we see that the average citizen of the United States travels perhaps 16% more within his own country than the

FIGURE 3
Movement of passengers and freight by mode

	Passenger-miles per person	% air	% rail	% hwy	% bus	% car
U.S.A.	6,940	13.4	0.7	86.0	1.7	84.3
Great Britain	5,356	0.6	6.5	92.9	8.5	84.4
Japan	4,150	3.8	40.4	55.8	11.4	44.4
France	6,774	1.7	10.0	88.3	9.7	78.6
Fed. Rep. Germany	5,854	1.3	6.6	92.1	12.8	79.3
Italy	5,716	0.0	8.3	91.7	17.4	74.3
Netherlands	5,804	0.7	6.9	92.5	9.5	83.0
Norway	5,796	4.1	6.8	89.1	11.3	77.8

	Surface freight ton-miles per person	% rail	% water	% hwy
U.S.A.	10,082	34.9	42.4	22.5
Great Britain	1,988	9.8	27.7	62.2
Japan	2,404	7.5	48.0	44.2
France	2,091	32.6	4.5	62.7
Fed. Rep. Germany	2,511	25.3	21.8	52.9
Italy	1,870	11.5	0.1	88.4
Netherlands	1,223	4.1	24.5	71.2
Norway	2,599	10.0	54.9	35.0
Spain	2,378	8.3	22.1	69.6

average citizen of Western Europe. (The difference for Japan is significantly greater, at about 40%.) The American traveler is way ahead of his or her European counterpart in use of airplanes (which is no doubt correlated to the lower U.S. airfares), a relatively uneconomical mode of travel. The Japanese make impressive use of their railway system to handle 40% of their passenger traffic, while of the Europeans, the highest are the French, at 10%. With the present decline of the American rail system, U.S. passenger traffic by rail is now less than 1% of the whole. Except in Japan, the private automobile has become the overriding mode by which people move in industrialized countries, providing between 74% and 84% of the domestic passenger-miles in the seven countries shown.

FIGURE 4
Intensity of highway use
(billion vehicle-miles per person)

	All vehicles	% from trucks	Passenger vehicles
U.S.A.	6,924	27.4	5,024
U.K.	2,986	15.6	2,484
Japan	2,392	31.2	1,613
France	3,935	17.6	3,206
Fed. Rep. Germany	3,371	9.0	3,035
Italy	3,132	12.9	2,691
Netherlands	3,454	11.7	3,023
Norway	2,791	12.7	2,388
Spain	1,231	22.0	942

In the realm of freight transport, the United States is faced with a unique situation. Due to the low population density and large size of the country, freight shipments per capita, in ton-miles, are four to five times as great as elsewhere in the industrialized world. To ship this freight, the United States relies very heavily on rail and water transport, and uses the lowest proportion of truck transport of any of the countries studied. The ability of the United States to use these two modes is the result of the great investments in infrastructure made as the country was being built. The maintenance and upgrading of these bulk transportation modes is clearly a requirement. It should be noted that the Japanese have planned the development of new industrial complexes in port cities, in order to minimize transportation requirements.

We can also examine the intensity of highway use from the point of view of a highway designer, looking at the number of vehicles and drivers, and the extent of their use, expressed in the number of *vehicle*-miles traveled rather than passenger-miles or ton-miles (**Figure 4**). These figures reflect the fact that Americans drive more cars than their fellows in Europe and Japan, where there will be more passengers per car as a rule. Americans drive on their highways more than any other nation. As of 1982, almost 7,000 miles were traveled by some motor vehicle on the highways for every person in the United States, compared to just under 4,000 for France, the nearest competitor, and only 1,200 for Spain.

Urban vs. rural transport

In consideration of the functioning of the transportation grid, density of population and of traffic provide the best scale. What may appear as an expensive mode of transportation per mile can be cheap if the density of traffic or the value of land in the area is sufficiently high. We have examined three countries in terms of densities, the United States, Great Britain, and Japan. **Figure 5** indicates the wide range of population densities which these encompass. In **Figure 6**, we examine the relative urbanization of these countries and their transportation grids. We have allocated airports and air traffic to urban transport, and considered all rail and water transport as occurring in inter-urban areas. In order to compare the various modes, we have expressed usage in terms of passenger-miles and ton-miles, rather than looking at vehicle-miles, which are not comparable between highways and mass transit modes such as trains, airlines, and water transport. In all three countries, the vast majority of the population is found in cities, although Great Britain shows the greatest urbanization both in population and in land use. In all cases, transportation land is approximately evenly divided between urban and inter-urban modes even though the transportation land use within rural areas is different in the different countries—e.g., the water transport system of Great Britain, although little used, requires 50% of such land, while that of Japan requires more than 25%, and that of the United States takes up just over 5%.

FIGURE 5
Population density (persons/square mile)

	Total	Urban	Rural
U.S.A.	64.95	8,030.31	14.77
Great Britain	594.16	13,003.56	55.35
Japan	821.87	23,343.37	179.09
France	254.13		
Fed. Rep. Germany	638.45		
Italy	484.36		
Netherlands	863.45		
Norway	32.56		
Spain	188.98		

FIGURE 6
Percent of urbanization

	U.S.A.	Great Britain	Japan
Population	77.4%	91.1%	78.8%
Land area	0.6	4.2	2.8
Transportation land	56.3	50.9	60.4
Transportation use			
Passenger-miles	65.2	45.7	31.9
Freight ton-miles	8.9	20.8	19.2
Transportation deaths	37.2	46.9	42.2
Highway use (vehicle-miles)	56.6	47.2	48.3
Highway injury accidents	70.9	76.5	68.8
Highway fatalities	38.0	50.5	44.6

Note: Urban transport includes all commercial air transportation; rural transport includes all rail and water transportation. Water transport area calculated on the basis of a standardized ship channel of 250′ width allocated to each mile of inland waterway, and air transport areas calculated from standard airport sizes.

The United States shows a relatively high proportion of passenger traffic using urban modes, a distortion in our figures (which account airline transport totally to urban usage), since the United States has a high usage of airlines rather than railroads for commuter transport. For freight traffic, the situation is reversed, with the relatively low urban percentage in the United States coming from the heavy use of railways for freight. Although Great Britain and Japan show similar percentage utilization of urban modes of freight transport, the pattern of inter-urban transport is very different in the two countries, with Great Britain using trucking for more than 50% of the freight movements, and Japan using domestic shipping for almost 60%.

Total transportation deaths are somewhat more frequent in rural than in urban areas in all three countries, with Great Britain showing the greatest concentration of deaths in urban areas. One reason that Great Britain shows up so poorly, is undoubtedly the poor level of safety management in its cities. Highway accidents (resulting in injury or death) are distributed between urban and rural areas in a pattern similar to the population distribution itself, but highway fatalities show a much lower percentage in urban travel. The variation in the pattern of transport deaths is determined by those occurring on highways, which make up by far the greatest proportion of the total (97% in the United States, 93% in Great Britain, and 94% in Japan).

The occurrence of such deaths is very closely related to the mode of transport used for people and freight. Thus, in the United States, urban transportation includes a significant fraction of air travel, which has an excellent safety record, although the factors which created that record are being eroded under the pressure of deregulation and cost-cutting. Great Britain, on the other hand, which has allowed its railroad

FIGURE 7
Death rates per billion passenger-miles, by mode

	Highway rate	Car rate†	Bus rate†	Air rate	Rail rate*
U.S.A.	33.4	22.0	4.8	1.1	15.0
U.K.	21.3	14.0	1.3	0.0	16.1
Japan	43.2	n.a.	n.a.	1.3	2.3
France	39.8	32.1	1.0		
Fed. Rep. Germany	34.7	26.1	0.8		
Italy	28.3	22.6	0.4		
Netherlands	19.8	13.5	0.2		
Norway	18.9	14.6	0.8		
Spain	54.5	43.2	2.8		

*Railway death rate calculated on fatalities of passengers plus the percentage of the remaining railway fatalities corresponding to the percentage which passenger trains make up of the total train-miles traveled.
†Occupant fatalities only.

FIGURE 8
Death rates per billion ton-miles by various freight transport modes

	Truck occupant death rate	Truck fatal accident rate	Freight train death rate	Water transport death rate
U.S.A.	12.1	30.0	1.2	0.2
U.K.	2.64	14.8†	3.8	3.4
Japan	n.a.	25.8*	0.2	1.7
France	8.69			
Fed. Rep. Germany	2.26			
Italy	5.11			
Netherlands	2.38			
Norway	3.56			
Spain	7.57			

*Only those accidents in which truck driver was at fault, or was the least injured of those parties equally at fault.
†Estimated from fatalities to fatal accident relations of 1977.

system to collapse, and has not created a domestic air travel grid, carries a higher percentage than the United States of its urban traffic in private cars, the most dangerous mode, and combines this with a relatively high percentage of freight movement in urban areas.

Modes of highway use

Within the general category of highway use, a distinction can be made between the rates of death of car and bus occupants per billion passenger miles, as shown in **Figure 7**. Clearly, the United States has adopted a relatively dangerous fashion of moving passengers on highways, using individual rather than mass transit, where the latter relies on the skills of fewer drivers, and the road-worthiness of fewer vehicles. The high rate of fatalities per passenger-mile for buses in the United States may be due to the presence on the highways of other vehicles which can inflict severe damage on a bus, in particular heavy trucks. In 1983, for example, 21 bus occupants were killed in collisions with heavy trucks. Even with this factor, passenger travel in buses is five times safer than in private cars in the United States.

The use of highways for freight movement is the most dangerous mode for the ton-miles moved (**Figure 8**). Although a relatively high percentage of the vehicles on American roads is trucks, as we have shown, the percentage of freight movements occurring on these highways is low, indicating that the rail and water network by which the United States is served is another major aspect in the relative safety of its roads. It should be noted that studies which consider only the death rates by vehicle occupant underestimate the danger of this mode, since trucks are far safer for their occupants than other vehicles. U.S. statistics show that there are twice as many fatal accidents involving trucks as there are fatalities among truck occupants (15,600 vs. 6,300 in 1982; 16,600 vs. 7,100 in 1984).

The U.S. super-highways

Given the amount of use which it receives, the U.S. highway system is the safest in the world. Two internal features make significant contributions to this result: the relatively large extent and use of expressways, defined for the United States as the Interstate Highway System, and the effective separation of pedestrians and bicyclists from motor vehicle traffic. In order to analyze the internal characteristics of the system, we will be considering death rates in terms of vehicle-miles traveled.

Figure 9 shows the difference between expressway and non-expressway fatality rates for urban and rural roads. **Figure 10** shows the percentage of pedestrian plus bicyclist ("external") fatalities in the United States as compared to eight other countries. Both these factors relate directly to infrastructure. The development of the Interstate Highway System required $107 billion between 1956 and the present, but the effects of this investment can be seen in the low fatalities and the high use-rate on that system. As the graph shows, this is particularly important for rural roads, where the fatality rate is the highest. **Figure 11** indicates that the United States is actually unusual in the low fatality rates in urban non-expressway driving, where fatalities to pedestrians are concentrated. The low rate of pedestrian and bicycle fatalities relates both to the high rate of car ownership and use, or personal infrastructure, and the provision of effective separation between motor vehicles and pedestrians or non-powered vehicles.

FIGURE 9
U.S. fatality rates for interstate and other highway systems
(1967-82)

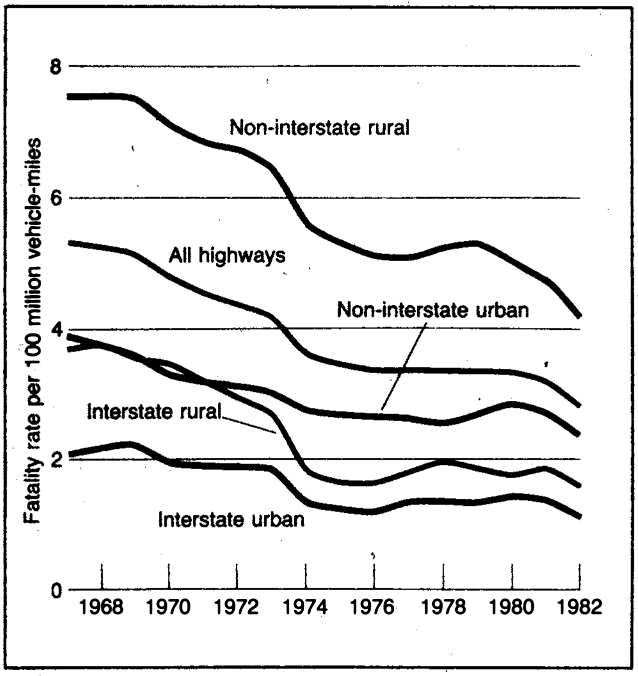

FIGURE 10
Percentage of highway fatalities that are not motorists

	Pedestrians	Bicyclists	Total external
United States	18.8%	2.4%	18.9%
Great Britain	32.4	5.1	36.5
Japan	30.4	9.7	40.3
France	17.6	6.4	24.0
Fed. Rep. Germany	23.7	8.8	32.5
Italy	21.6	7.5	29.1
Netherlands	14.8	21.3	36.1
Norway	22.7	6.7	28.7
Spain	23.2	1.9	25.1

Safety vs. density: Is there a trade-off?

Figure 12 shows the density of use, in vehicle-miles per square mile of highway, and in passenger-miles and ton-miles per square mile, of the total transportation land in each of these three countries. In all cases, the expressways carry by far the greatest density of highway traffic. Other rural highways carry a density of traffic which is greater than that of urban highways, since a large fraction of city streets, those in residential areas, carry very low flows. These patterns are consistent over the three countries, even though the average densities vary by more than three-fold.

FIGURE 11
Death rates by highway type and location
(fatalities per billion vehicle-miles)

	Expressways	Other rural roads	Other urban roads
U.S.A.	12.76	41.81	23.21
Great Britain	10.58	39.83	37.96
Japan	10.26	53.06	40.11

In looking at the overall density of passenger and freight traffic, the patterns are more disparate. We see, for example, the high density of passenger-miles per square mile of railroad land, a specific advantage for a country like Japan, where land is at a premium. The variation in the modes of transport in the three countries is pointed up by this table, as we see that the United States operates at a high density in the long-distance modes of passenger air traffic, and rail and water freight traffic, combined with extremely low density of highway and passenger rail use. Great Britain shows the opposite pattern, with relatively intense use of highways and passenger rail travel, but little else. Japan, as well as its intense use of rail area for passengers, shows heavy use of air area for passenger travel, and a relatively high use of all highways for freight movement.

For ease of comparison, a "ton"-mile estimate has been made of passenger traffic so that the total use of each area can be compared. For rail and air, passenger traffic is very similar to freight, with an estimate of .08 tons/person for rail, and .1 tons for air, where more baggage is carried and more facilities are required. For highways, the tonnage equivalents are calculated by the vehicle-miles, since one of the features of personal transportation is that the vehicle is transported and available at the end of the trip. Each vehicle mile is considered as 1.25 "ton"-miles for the United States, 1.0 for Great Britain, and 0.75 for Japan, a very general indication of the relative size of vehicles and the use of two-wheelers for transportation. The results of this approximation of overall densities are also shown in **Figure 12,** with density rankings diminishing from water, to rail, to airports or highways, depending on the development of domestic air travel.

The response of the different modes of travel to density can be seen in the fatality rate per "ton"-mile as shown in **Figure 13.** Air and water fatality rates are the lowest, with water rates being negatively correlated to density, and air rates positively correlated. Although these are indications,

FIGURE 12

Density of use of transportation land

	U.S.A.	Great Britain	Japan
Million vehicle miles/sq. mi. of highway			
Total	12.8	40.5	25.3
Expressways	58.8	102.9	93.7
Other urban	9.8	26.9	18.7
Other rural	12.2	68.3	34.6
Million passenger-mi./sq. mi.			
Air	414.0	18.2	323.4
Highway	11.0	67.5	24.6
Railroads	2.7	75.1	619.8
Million ton-miles/sq. mi.			
Highway	4.2	16.6	11.2
Railroads	200.1	42.4	66.6
Water transport	304.1	20.9	100.0
Million "ton"-miles/sq. mi.*			
Air	50.9	10.3	60.2
Highway	15.8	50.8	29.6
Railroads	200.3	48.4	116.1
Water	304.1	20.9	100.0

*"Ton"-miles have been estimated using .08 tons/person for rail, .1 tons for air, and considering each vehicle mile as 1.25 "ton"-miles for the United States, 1.0 for Great Britain, and 0.75 for Japan, a very general indication of the relative size of vehicles and the use of two-wheelers for transportation.

FIGURE 13

Fatalities per billion "ton"-miles, by mode

	Air	Highway	Rail	Water
U.S.A.	10.9	23.0	1.4	0.2
Great Britain	0.0	28.5	28.3	3.4
Japan	12.8	44.1	12.5	1.7

not proofs, it appears probable that water safety would increase with the amount that the existing navigation routes are used, while air safety, given the available level of technology and the regulatory requirements on airports, would decrease with greater densities. Rail use tends to be safer with increasing density of use. This would not be expected to hold in a developing country, where equipment or signaling capability could easily be overloaded, but is a natural result in more advanced countries. For railroads in particular, where the major safety problem is the interaction of trains with cars and pedestrians, this relationship reflects the ability to invest heavily per square mile in resolving these conflicts. In the case of highways, no density effect can be seen, either in the totals, or in the breakdown into rural and urban areas. However, when the density and safety relationships of expressways are considered, we see that the high investment, justified by the high density of use, does result in a significant improvement in safety, but that such improvement is apparently independent of the density of use.

The regulation of traffic flow

One of the major reasons for the relative safety of American highways, is the lack of pedestrian accidents. The separation of passengers (and bicycles) from vehicles, of course, is most difficult to achieve in urban areas, and there becomes dependent both on the mapping of traffic flows and their control. In urban areas of the United States, 38% of the fatal accidents which occurred at junctions occurred where there were no traffic controls. This was not the result of such intersections being the most common, as is indicated by the results of a Canadian study, where the rate of accidents per pedestrian-vehicle interactions ranged from 12 to 200 times as great at uncontrolled intersections, compared to those with signs or signals.

This is one aspect in which the United States has a considerable advantage over European countries, since a large proportion of its residential areas have been developed since the advent of the automobile. In many European cities, the streets were laid out, and many of the buildings built, 500 years ago. An obvious answer to the problem is a modern urban railroad system like the Paris Metro.

Another aspect of separation and control is the interaction between trains and autos. In the United States, there has been an ongoing effort to decrease the number of at-grade crossings, and to improve the control at those intersections which remain. The importance of this aspect is illustrated by the fact that half of the train fatalities in the United States were motor-vehicle occupants at grade crossings. Between 1975 and 1984, the number of grade crossings in the United States decreased from 219,161 to 200,730, and the number of such crossings with active warning devices, such as gates, flashing lights or bells, has increased from 49,369 (22.5%) to 63,411 (31.6%). Some technological progress has been made in this area, most notably in the invention and installation of timed motion sensors, which provide a standard warning period, to replace the old distance-sensitive devices, which would provide too little warning time for a fast-moving train, and signal so early for a slow train that drivers were encouraged to disregard the signal and cross in front of the train.

Auto size and safety

The American automobile has long been derided as a gas-guzzler, a conspicious consumer of energy, transportation funds, and affection. Although Americans have placed an excessive emphasis on the style and status characteristics of their transportation, large, heavy, and relatively powerful vehicles offer far greater safety than motorcycles or smaller, lighter cars.

NSIPS/Philip Ulanowsky

The issue of highway safety must be located as a characteristic of the overall transportation system, a fundamental aspect of the national economy. In the United States, the system historically had one intrinsic problem to overcome: the large size and relative underpopulation of the continent.

In the United States, the death rate for motorcyclists is approximately 350 per billion vehicle-miles, more than 100 times as great as that for motor-vehicles in general. Motorcycles actually suffer relatively few accidents in terms of the number registered, with 1.7% of the accidents for 3.2% of all registrations. This tends to disprove the theory that the high death rates on motorcycles are the result of incompetent or reckless driving. However, in 1984, when the total number of motorcyles involved in accidents was 570,000, the number of motorcycle riders injured in such accidents was 510,000. In other words, a rider in an accident had a 90% chance of injury, wheras an occupant of a car has less than a 5% chance of injury. Thus, any country where motorcycles are widely used for transportation, for financial or energy-conservation reasons, is subjecting its citizens to an inordinately high risk of injury or death.

FIGURE 14

Motorcycle death rates and fatalities and vehicle-miles as % of highway user totals

	Deaths/billion vehicle mile	Fatality %	Vehicle-mile %
U.S.A.	203.27	13.59	1.51
Great Britain	156.61	29.48	4.24
Japan	40.98	17.65	10.74
France	108.43	24.42	10.35
Fed. Rep. Germany	265.30	22.68	3.20
Italy	63.30	27.60	14.55
Netherlands	130.26	25.15	4.36
Spain	387.57	15.37	3.63

The contrast between the percentage of vehicle-miles from motorcycles and mopeds, and the percentage of highway fatalities for which they account, is shown in **Figure 14.** A similar, although less drastic difference is observed, when cars of different sizes are compared. The United States collects statistics on fatal accidents, which include the size of the autos involved. In 1983, cars with wheelbases under 96 inches were involved in 17.6% of the fatal accidents, but their occupants suffered 21.4% of the fatalities. Cars with wheelbases over 120 inches, on the other hand, were involved in 11.7% of the accidents, and their occupants incurred only 9.1% of the fatalities. Thus, another reason for the relative safety of American highways is the remaining tendency towards "full-size motor" vehicles.

In summary, then, the relatively high rate of highway deaths per person in the United States can be attributed to the heavy use of passenger cars, the most dangerous mode of personal transportation, rather than trains and buses. The low rate of deaths per vehicle-mile and per "ton"-mile on U.S. highways can be attributed to the reliance on non-highway modes of freight movement, the provision of a network of extremely well-engineered, high-quality roads, the ability and determination of American city planners to separate pedestrian and bicycle traffic from motor vehicles, and the general tendency and ability of Americans to buy larger and heavier vehicles for their personal use.