THE SPEED REVIEW:
APPENDIX OF SPEED WORKSHOP PAPERS

Prepared by

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Abstract

An important part of the speed review recently undertaken for the Road Safety Bureau, Roads and Traffic Authority N.S.W. in conjunction with the Federal Office of Road Safety was a meeting of 45 Australian experts with research, government authority, and motoring backgrounds, as well as a keynote speaker from Sweden, to identify current problems and issues in Australia.

The workshop encompassed **six** keynote addresses on speed research and current issues and developments in N.S.W., Victoria, and overseas. This appendix volume to the main report (FORS, CR 127 or RSB CR 3/93) includes the papers presented by the invited guests at the workshop on Monday 23rd November 1993 at University House in Canberra.

Keywords
Speeding, Accidents, Enforcement, Speed Limits, Environment, Research needs, Driver Behaviour, Countermeasures.

Notes

(1) This report is jointly produced by FORS and RSB and is disseminated in the interest of information exchange.

(2) The views expressed are those of the author(s) and not necessarily those of the Commonwealth Government or RTA (NSW).

(3) The Federal Office of Road Safety publishes four series of reports:

(a) reports generated as a result of research done within FORS are published in the OR series;

(b) reports of research conducted by other organisations on behalf of FORS are published in the CR series.

(c) reports based on analysis of FORS statistical data bases are published in the SR series,

(d) minor reports of research conducted by other organisations on behalf of FORS are published in the MR series.

(4) The Road Safety Bureau publishes two series of reports:

(a) reports generated as a result of research done within RSB are published in the RN series,

(b) reports conducted by other organisations on behalf of RSB are published in the RSB's CR series.

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ROAD SAFETY 2000
REVIEW CONFERENCE, SYDNEY, NOVEMBER 18, 1992

Goran Nilsson
Swedish Road & Traffic Research Institute

- ROAD SAFETY STRATEGIC PLANNING IN EUROPE
- SWEDISH ROAD SAFETY PROGRAM.

ROAD SAFETY STRATEGIC PLANNING IN EUROPE.

The most developed countries of Europe are endeavouring to establish some kind of federation, which for the moment is represented by the 13 member countries of EC, the European Community. Sweden and some other countries have at the political level decided to join the community, but how and when is still a question.

At the same time in the eastern part of Europe, borders between new and old states are changing, a process opposite to the integrating intention of EC.

In 1991 an expert group inside EC presented a report (the Gerondeau Report) on traffic safety strategy in EC with proposals for performance measures and targets which ought to be introduced in some of the countries, even if they were not going to be introduced in all EC countries.

The target level recommended is a 20-30% reduction in deaths and serious injured in the EC countries by the year 2000.

Corresponding traffic safety programs exist for almost all European countries, with target reductions of the magnitude of on average 25%, from the numbers killed and injured during previous years to the year 2000.

In Figure 1 the traffic safety situation in the EC countries is shown and expressed by the number of killed per million inhabitants. The total number killed in these countries is about 50,000 a year and the total number of inhabitants is about 325 million (1989). This means on average more than 150 killed per year in traffic crashes per million inhabitants. The Netherlands and United Kingdom have values less than 100 and France, Spain, Luxembourg and Portugal have values over 200, Portugal with more than 300 killed per year per million inhabitants.

The average value for North America (Canada and US) is more than 190 killed per year per million inhabitants. The figure for Sweden was in 1991 less than 90 and for Australia less than 150 killed per year per million inhabitants or close to the average in the EC countries.

In Table 1 the fatalities per 100 million vehicle kilometres travelled is presented for EC countries, Canada, US and Japan. In this case the values of Netherlands, UK, Canada and US are around 1.5 killed per 100 million vehicle kilometres.

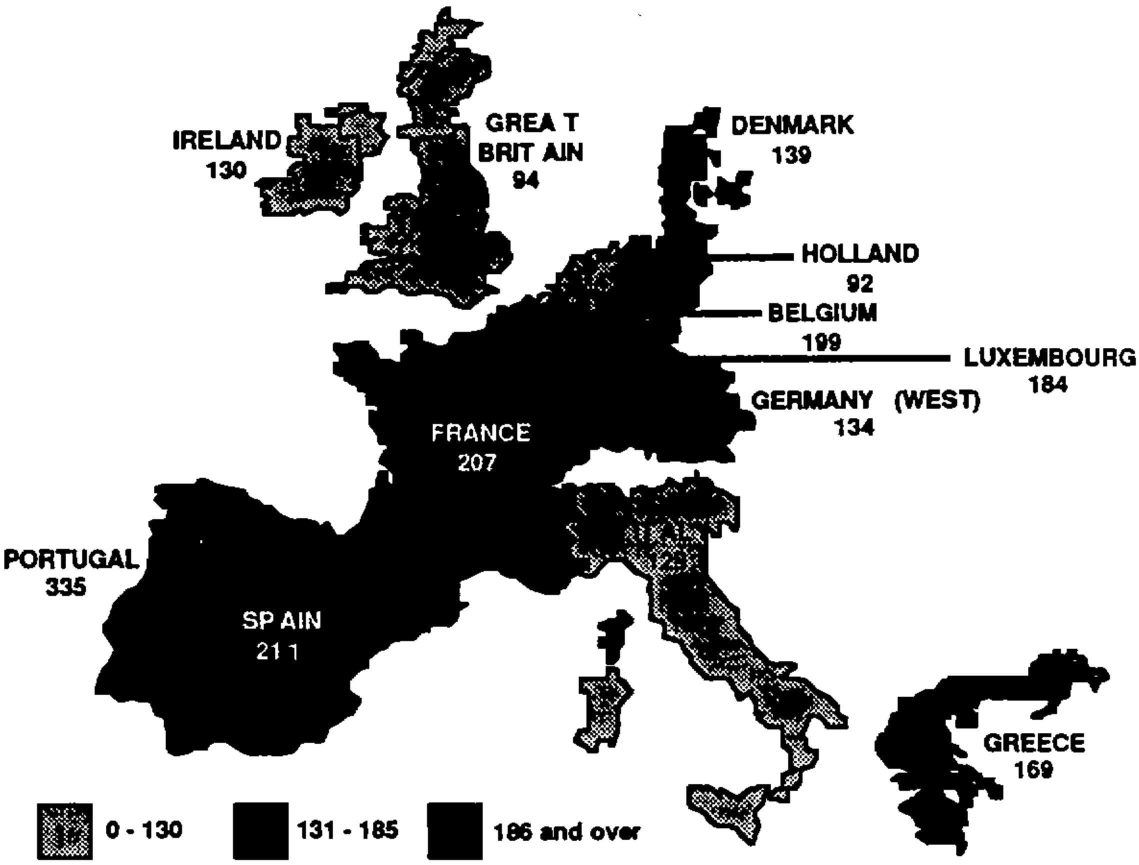
TABLE 1. **Fatalities per Hundred Million Vehicle Kilometres in EC countries, Canada, USA and Japan.**

	POPULATION (Millions)	Million Vehicle Kilometres Travelled	FATALITIES	Fatalities per 100 M VKT
Belgium	9 876	54 600	1 967	3,60
Germany	61 238	427 400	8 213	1,92
Denmark	5 129	35 011	713	2,04
Spain	38 914	99 159	8 252	8,32
France	55 784	399 000	11 497	2,88
Greece	10 010	24 000	1 738	7,24
Italy	57 391	288 000	7 494	2,60
Ireland	3 538	21 947	463	2,19
Luxembourg	372	2 956	84	2,84
Netherlands	14 715	94 090	1 366	1,45
Portugal	9 778	31 200	3 294	10,56
United Kingdom	55 487	363 102	5 052	1,39
TOTAL EC	322 330	1 840 365	50 133	2,72
Canada	25 950	275 000	4 200	1,53
USA	245 785	3 240 938	47 093	1,45
Total North America	271 735	3 515 938	51 293	1,46
Japan	122 833	575 558	13 447	2,34

The value for Sweden (not in the table) is less than 1.3 and the average for Australia less than 1.5. This can be interpreted as Sweden having a very favourable traffic safety situation. At the same time however, the methods to estimate vehicle mileage differ between the countries and thereby some of the estimates are probably biased.

Some of the European countries have about 500 motor vehicles per 1000 inhabitants but, compared with the US with more than 750 motor vehicles per 1000 inhabitants, car ownership and car use could still increase a lot in Europe. If this proves to be the case during the Nineties, fatalities will increase in Europe. The overall economic situation, on the other hand, indicates that the development will be very slow during the coming years in most European countries.

Fig. 1. FATALITIES PER MILLION INHABITANTS IN THE EEC



EXPERIENCE OF TRAFFIC SAFETY PROGRAMS

It is difficult to give a description of if and to what extent definitions of traffic safety targets and formulations of traffic safety programs have contributed to a better traffic safety situation compared to a situation without defined targets and traffic safety programs presented. However the overall experience is that target values are important, from many points of views, and extremely important in order to work out integrated traffic safety programs involving many authorities.

The problem of implementing the programs or the proposed measures, which is always the main problem, will in most cases be facilitated if target values are presented and compared with the existing situation.

The political target or the national target is primarily expressed in terms of reducing the annual number of killed in road traffic by x percent in a defined number of years. In many cases other casualties are included with fatalities.

In some cases the national target is distributed over different road user groups, car occupants and vulnerable road users or accident groups, accidents with pedestrians (children) or accidents with drunken drivers (young drivers). Targets are then set for these groups such as a reduced risk, or the number being reduced by a battery of proposed measures.

Another way, practised in Sweden, is to identify existing measures and their safety effect, investigate the potential of using these measures and create a priority list containing the battery of known measures to reach the national target with minimum costs for the society. One problem or perhaps benefit is that a measure which has not been proved to have a positive traffic safety effect or have a very little potential (i.e. will influence very few accidents) is out of consideration until its effect or potential has been proved.

The overall goal in Sweden is to continuously reduce the number of fatalities and casualties with a specific goal that the fatalities shall be less than 600 in the year 2000 (747 fatalities in 1991).

The overall goal in Australia as set out in the National Road Safety Strategy, is a maximum reduction in road deaths and seriously injured before (!!) the year 2001 with a specific goal that the number of deaths per 100,000 inhabitants shall be below 10 by the year 2001.

The question of whether the targets are realistic, optimistic or just a challenge can of course be discussed. Very few European countries have reached targets during the Eighties but looking at the situation in Australia a target value expressed for the Eighties - 30% reduction in road deaths by the year 1990 - would have been reached. The same concerns a 50% reduction of deaths related to vehicle mileage.

Many European countries have had the same experience during the Seventies but target values were not expressed except for Finland and Japan. Both these countries reached their targets to reduce the number of fatalities by 50%, as they expressed their target when the number of road deaths were the highest ever, as in Australia during the Seventies.

Experience from a lot of industrialised countries is that the highest peak will be followed by new peaks but of decreasing magnitude. The reasons for that can be given in different way:

- The awareness of safety and the acceptance of measures and traffic rules will be reduced in the society when the number of fatalities and casualties is decreasing. Speed is given priority instead of safety and the improvement of the risk situation will be very small or negative.

- The battery of relevant and existing measures introduced at a certain time is reaching their optimal effects and the fundamental risk levels change very little, which means that the number of deaths and injured would increase proportional to car traffic (almost all use seat belts or helmets etc.).

- The use of cars changes in society when women have their driving licence to the same extent as men in the younger ages, which means that the proportion of inexperienced drivers will be extremely high during some years. The same can be valid for the use of motorcycles as the use reaches peaks depending on the interest by the parents (father) generation often related to high birth figures.

Independent of the background for the second or coming peaks, society will react and no politician can accept increasing numbers of fatalities at the same time as the demand and acceptance of safety measures increases in society.

The second case above is of course the main problem and must result in introducing more restrictive existing measures and new measures, for example reduced speed limits and increased installation of air-bags in cars. These two examples can to some extent summarise the problem.

If the experienced driver has a choice he will accept air-bags but not lower speed limits. The inexperienced driver accepts perhaps lower speed limits instead of driving with a potential bomb in the car. But if the air-bag is mandatory all have to accept the measure. In time both measures are probably necessary and the question is then how to convince the experienced driver to drive at lower speeds, when he already has invested in an air-bag and uses the seatbelt (and has a heavy car).

TARGET YEARS

One question is whether it is of any great advantage to reach the target value in a given period of time? What will happen if the target value is reached before the target year? Perhaps target values shall not be tied to a target year. The target shall be reached as soon as possible and be replaced with a new target value at the same time as measures are introduced and/or the forecast traffic situation changes.

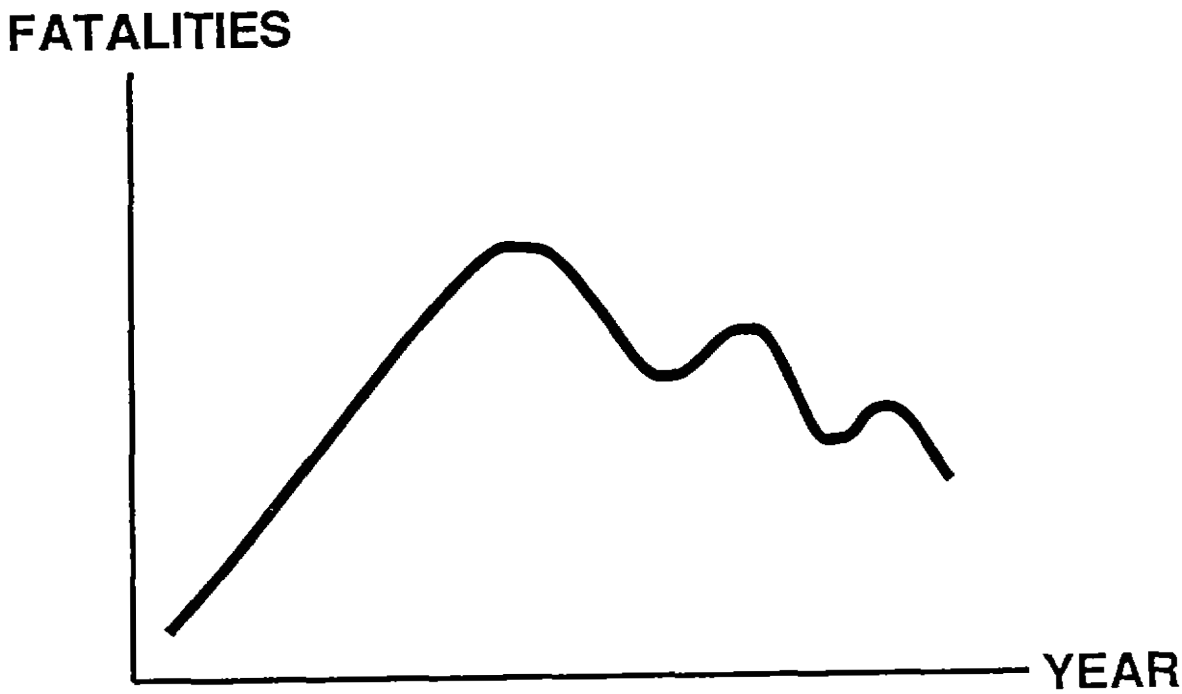
This may apply to the overall goal for road safety in Australia.

Before leaving target values it is probably favourable to use risk concepts instead of numbers. The US road safety target is to reduce the fatality rates by 7% annually. (Fatality rate = number of fatalities per vehicle mileage).

This kind of target is of course difficult to explain to road users and need also a relevant monitoring system of traffic development.

In the English-speaking parts of the world the 3Es' concept has a long tradition: Education, Engineering and Enforcement. The above can mainly be addressed though the education concept and is in that sense a new approach in the field of traffic safety education, using target values to illustrate the traffic safety work and the efforts needed to reach the target values.

The measures can mainly be related to the engineering and/or enforcement concept.



Follow-up study of speeds on rural roads
Measurements made during 1991

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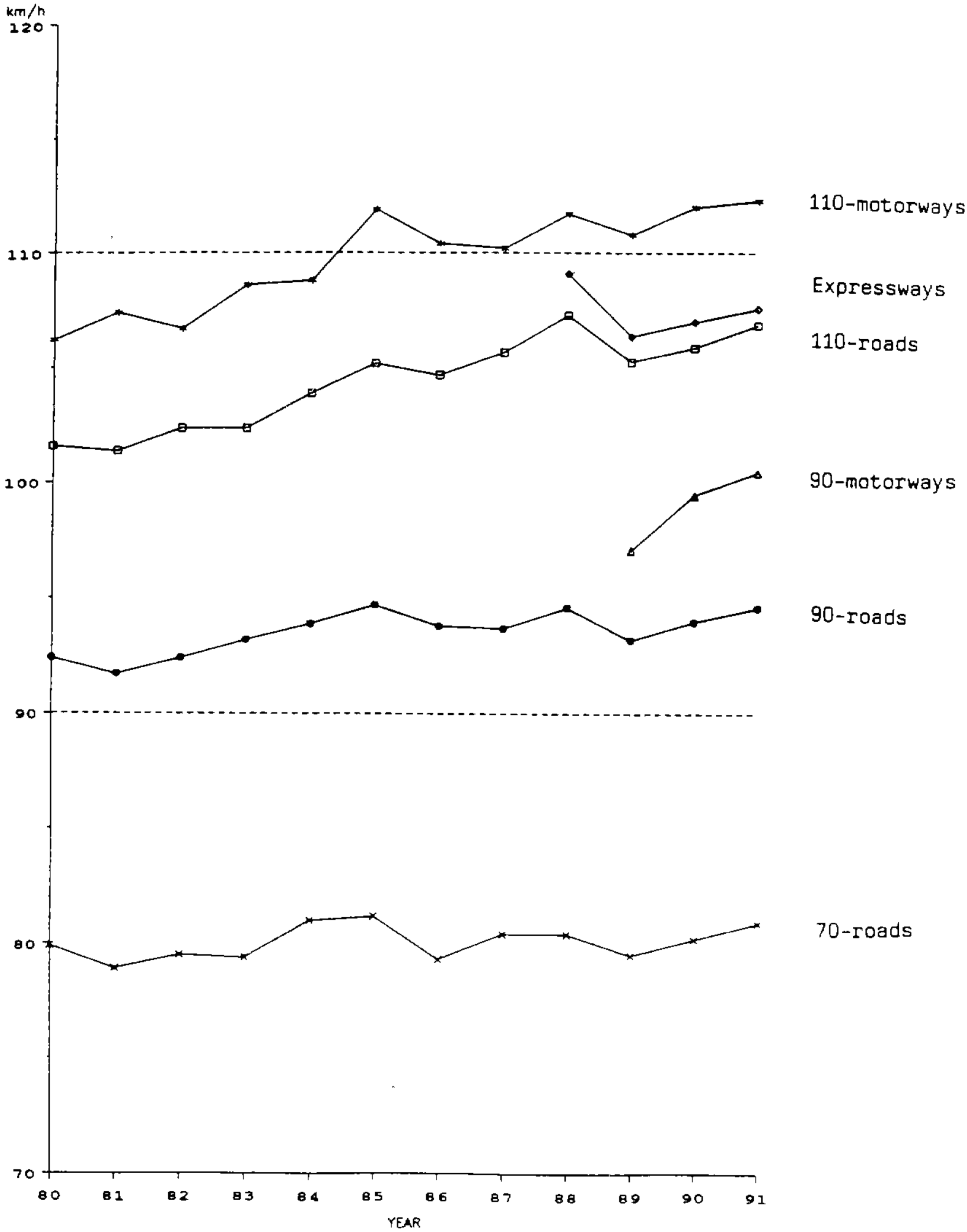
SUMMARY

Measurements recorded during 1991, the twelfth year of the Institute's follow-up study of speeds on rural roads, are presented in this report. The follow-up study consists of spot speed measurements. This year, measurements were carried out at 63 different locations on five to six occasions during the year, making a total number of 347 measurements. The locations chosen are straight, level roads with varying speed limits and cross-sections. The results from previous years have been presented in references (11)-(21).

The speed trend for cars during the years 1980-91 on straight and level rural roads with dry road surface conditions is shown below for different road categories.

Speed trend 1980-1991 for different road categories



In 1991, speed has increased on all road types in this study.

Two-lane roads, 70 km/h speed limit	+0.7 ±0.6 km/h	significant
Two-lane roads, 90 km/h speed limit	+0.6 ±0.5 km/h	significant
Two-lane roads, 110 km/h speed limit	+1.0 ±0.8 km/h	significant
Expressways, 110 km/h speed limit	+0.6 ±0.8 km/h	not significant
Motorways, 90 km/h speed limit	+1.0 ±1.0 km/h	significant
Motorways, 110 km/h speed limit	+0.3 ±1.0 km/h	not significant.

The table below shows the mean speed and proportion of the following types of vehicle exceeding the applicable speed limit: cars (P), cars with trailers (PS), buses (B), lorries (L) and lorries with trailers (LS) 1991 on dry road surfaces.

Road category		Mean speed (km/h)					Proportion of vehicle (%) exceeding speed limit				
Speed limit	Width (meters)							70	90	70/90	70
		P	PS	B	L	LS	P	PS	B	L	LS
70	4.7-6.5	81	75	76	75	74	85	72	88	70	73
90	6.5-7.0	86	76	83	81	79	37	75	22	90	92
	8.0-9.5	94	81	88	85	82	66	92	42	97	98
	11-13	93	80	89	84	81	64	88	46	95	96
	MV	101	81	93	90	83	85	92	66	51	95
110	12-13	107	83	95	90	83	39	95	71	97	98
	ML	107	84	94	90	82	41	96	67	51	99
	MV	113	85	98	94	83	61	97	83	66	99

The speed is weighted in regard to the number of vehicles in each measurement.

The speed trend measurements were made possible through funding from the VTI, Swedish National Road Administration, Swedish Road Safety Office and National Swedish Road Safety Organisation.

Göran Nilsson
Swedish Road and Traffic Research Institute (VTI)

RELATIONSHIP BETWEEN SPEED AND SAFETY
CALCULATION METHOD
Change in mean (median) speed v_0 to v_1

ACCIDENTS (y)

Fatal accidents

$$y_1 = \left(\frac{v_1}{v_0}\right)^4 y_0$$

Fatal and severe accidents

$$y_1 = \left(\frac{v_1}{v_0}\right)^3 y_0$$

All injury accidents

$$y_1 = \left(\frac{v_1}{v_0}\right)^2 y_0$$

CASUALTIES (z)

Fatalities

$$z_1 = \left(\frac{v_1}{v_0}\right)^4 y_0 + \left(\frac{v_1}{v_0}\right)^8 (z_0 - y_0)$$

Fatalities and severly injured

$$z_1 = \left(\frac{v_1}{v_0}\right)^3 y_0 + \left(\frac{v_1}{v_0}\right)^6 (z_0 - y_0)$$

All injured

$$z_1 = \left(\frac{v_1}{v_0}\right)^2 y_0 + \left(\frac{v_1}{v_0}\right)^4 (z_0 - y_0)$$

Example 1. Speed increase from 85 to 90 km/h. Number of fatal accidents= 100 and the number of fatalities =110 at 85 km/h

$y = 1{,}059^4 \cdot 100 = 125.7$
increase 25,7 %

$z = 125{,}7 + 1{,}059^8 \cdot (110-100) = 141.5$
increase 41.5 %

Example 2. Speed reduction from 100 to 90 km/h. Number of injury accidents= 1000 and the number of injured = 1500 at 100 km/h (fatalities included)

$y = 0{,}9^2 \cdot 1000 = 810$
decrease 19 %

$z = 810 + 0{,}9^4 \cdot (1500-1000) = 1138$
decrease 24,1 %

The above calculations are estimates of the safety situation if only the speed situation is changed.

The calculations are based on emperical results from at least 50 different investigations of safety effects from speed limit changes both in rural and urban areas. The theory background is based on that

- accidents reported by the police are proportional to speed situation (v) and the probability of an injury accident if the accident is reported is also proportional to the speed situation (v)

or

- the probability of an reported injury accident is proportional to the kinetic energy (v^2)

and

- the probability of a fatal accident if an injury accident is also proportional to v^2.

From this follows the expressions for fatalities, fatalities and injured and all injured.

Data needed

Existing speed situation and the predicted new speed situation.

Accident statistics. Numbers of fatal, (severe) and all injury accidents and the numbers of fatalities, severely injured and all injured.

A norwegian investigation (not published) of the result from 75 reports on significant safety effects of speed changes shows the following results

Table . Number of reports presenting different results of the relationship between speed and accident changes.

	ACCIDENTS		
SPEED	+	0	–
+	4	3	2
0	-	2	3
–	1	-	60

SUMMARY - AUTOMATIC SPEED ENFORCEMENT IN SWEDEN

The experiment

In April 1990, experiments were started in Sweden with automatic speed surveillance of eight selected sections of road. The experiment covered a period of two years, April 1990 - March 1992. Later, these sections were extended with a further eight and for four of these the experiment was lengthened to June 1992.

The experiment thus comprises a total of 16 sections of road, of which eight consist of two-lane rural main roads with a speed limit of 90 km/h and eight of two-lane urban main roads with a speed limit of 50 km/h.

At the request of the National Police Board, the VTI has taken part in designing the experiment and has undertaken to evaluate the results with regard to effects on speeds and also road user opinion on automatic speed surveillance, as well as analysing if possible the effects of the experiments on road safety.

The experiment is based on a statistical experiment, in which pairs of equivalent road sections have been selected jointly by the National Police Board, road management authorities and local police forces. One of the sections in each selected pair has been chosen at random and equipped with automatic speed surveillance. The two sections are designated the test section and control section.

Repeated speed measurements and observations of accidents have been performed on both the test and control sections before and during the experiment.

In this system, the speeds of passing vehicles are recorded at fixed installations provided with cameras photographing vehicles exceeding a certain predetermined speed. The registration number of a vehicle is noted from the photograph. The vehicle owner is then contacted to identify the driver with the aid of the photograph.

Evaluation of identification methods and other police assistance is not dealt with in this report. However, the VTI has been asked to follow up the execution of the experiment in regard to the number of surveillance periods and the time distribution of these based on the time of day and day of the week.

Each section was provided with two camera sites with varying distances between them and different surveillance direction. On nine sections, two (in one case, three) consecutive camera sites faced the same direction, while on seven sections surveillance was performed with one camera site in each direction. The distance between the cameras varied from approximately 500 metres to 11 kilometres. In all cases, the camera sites were preceded by signs warning drivers of automatic speed surveillance in their particular direction.

On all test sections, speeds have been recorded by following a sample of cars before and during the experiment. The number of cars followed was the same in all surveillance periods on the particular test section, but varied between the sections.

By using these car following studies, it has been possible to describe the direct effect on speeds as a result of automatic speed surveillance, both locally in connection with automatic speed surveillance and totally over the test section.

The experiment comprised a total of 110 km of rural main roads with a speed limit of 90 km/h and 17 km of urban main roads with a speed limit of 50 km/h, together with approximately the same length of control sections.

At the end of the experiment, surveys based on questionnaires were conducted with different samples of car owners to determine their experience and attitudes regarding automatic speed surveillance.

Results

Execution of the experiment

The scope and duration of the experiment are probably unique. Thus, there should be outstanding potential for resolving a number of questions.

Even if the design of the experiment has been modified for various reasons while the experiment was in progress, it largely follows the original plans.

In total, speeds of 920,000 vehicles have been recorded at the 33 camerasites on 781 occasions. 14,000, or 1.5 %, of the passing vehicles have been photographed. The surveillance periods, which lasted an average of four to six hours on each occasion, were evenly distributed over the day (24 hours) and days of the week. The vehicles photographed have exceeded the 50 km/h speed limit by at least 13 km/h and the 90 km/h speed limit by at least 14 km/h. The levels notified to the car owner have been reduced by three km/h and four km/h respectively. This means that the tolerance in the experiment was somewhat greater than with other speed surveillance methods during the same period.

Because the automatic speed surveillance was preceded by warning signs, the majority of the car drivers were able to adapt their speed in good time before reaching the cameras. Without this warning, or with a lower tolerance, considerably more vehicles would naturally have been photographed. However, the aim of the experiment was to reproduce a situation with general application of automatic speed surveillance, while taking into account the investigation resources at the disposal of the police forces.

Measurement of speeds on test and control sections

The speed measurements performed on all the studied sections prior to the experiment have been repeated during the experiment on those sections chosen as test and control sections on the corresponding day of the week after an interval of one year. The locations chosen for speed measurements on the test sections were chosen without regard to the subsequent location of the camera sites, which means that they may be treated as a random sample of locations on sections with automatic speed surveillance. The same applies to corresponding locations on the control sections. A certain loss of data has occurred in the case of repeated measurements on rural main roads, while the urban measurements are complete.

These speed measurements show that speed decreased on average by just over 3 km/h on the test sections, both on rural main roads (90 km/h) and urban main roads (50 km/h). On the control sections on rural main roads, speeds increased by approximately 0,5 km/h, while speeds decreased by about 0,5 km/h on the urban test sections.

Speed recording along the test sections

The most comprehensive analysis of the effect of automatic speed surveillance concerns car following studies performed on the test sections before and during the experiment. Like the speed measurements, these were repeated one year after the "before period" on the same day of the week. The speed measurements and car following studies were performed on different occasions.

Change in journey time on test sections

Apart from the descriptions of car following in both directions before and during the experiment on the test sections, the method has also made it possible to analyse the change in journey speed on the latter sections. The studies of car following entail following a sample of vehicles along the section. The driving sequence has been recorded for a total of 2,500 vehicles distributed among the 16 test sections both before and during the experiment.

An analysis of the change in journey speed shows that the journey speed in those directions subject to surveillance decreased by an average of two to three km/h. The higher the original journey speed, the greater the decrease. In directions not subject to surveillance along the test sections, journey speed decreased in urban areas by approximately one km/h, while in rural areas there was a tendency to increased journey speeds in directions not under surveillance.

Changes in speed on test sections

The analysis of the driving sequence along the test sections in both directions is summarized as follows:

- The speed level at the camera sites in the direction under surveillance fell by 5-10 km/h. The higher the original speed level in relation to the speed limit, the greater the speed reduction.

- The effect decreased with increased distance to or after each individual camera site in the direction under surveillance. Normally, speeds were influenced within 500 metres before and after the camera site in urban areas and within 1,000 metres before and after the camera site in rural areas.

- Speed reductions at camera sites for surveillance in the opposite direction exist, but the reductions decreased with time, especially in rural areas.

- On the parts of the sections where the original speed level was higher than the speed limit, better adaptation to the speed limit was obtained through lower speeds, even when speed was not directly influenced by the camera site. Increased adaptation to the speed limit through higher speeds can be distinguished in certain cases where the original speed level was lower than the speed limit in the before situation.

- On those sections where the experiment was in progress for two years, the initial effects diminished and became increasingly limited to the immediate vicinity of the camera sites in the direction under surveillance.

In brief, considerable speed reductions were obtained at the camera sites, especially in the direction under surveillance. At the same time, the car drivers' adaptation to the speed limit on the sections has increased, mainly with lower speeds as a result, but also higher speeds in some cases.

The variation or standard deviation in journey speeds has been analysed together with changes in journey speed. In general, both the journey speed and variation in journey speed decreased on most test sections in urban areas, while reduced journey speed on rural main roads led both to decreased and increased dispersion in journey speed.

The car following studies have also made it possible to describe the total speed distribution along the test sections for the followed vehicles and the way in which this has changed as a result of automatic speed surveillance.

From this, it can be seen that in the directions subject to speed surveillance, the speed level decreases because the whole speed distribution is shifted towards lower speeds and especially because the frequency of the highest speeds is reduced.

In those directions not under surveillance, the speed distributions are not notably changed, which also applies in several cases where the original speed level is lower than the speed limit.

Car drivers' attitudes to automatic speed surveillance

The questionnaire surveys conducted at the end of the experiment show that 95 % of car owners in Sweden were aware of automatic speed surveillance and that 62 % had seen one or more camerasites. Nearly all those living in the counties where automatic speed surveillance is in use and whose annual driving mileage exceeded 20,000 kilometres had heard about the experiment and 90 % had seen the cameras.

44 % thought that automatic speed surveillance ought to be introduced on more roads, while 46 % were of the opposite opinion. 56 % thought that automatic speed surveillance leads to higher speeds, while 36 % did not think so.

6 % considered that the car owner should be made responsible for speed infringements, regardless of the actual driver of the car.

In general, the longer the annual driving distance of the respondent, the greater was his or her experience of automatic speed surveillançe, while the proportion desiring more sections with automatic speed surveillance decreased.

A similar telephone survey was conducted at the same time by the University of Uppsala and was aimed at the country's motoring journalists. Their experience and views concerning automatic speed surveillance were the same as those obtained in the questionnaire to persons with a high annual driving mileage. The average annual driving distance for the journalists interviewed was 40,000 kilometres.

It is important to note that information on the experiment with automatic speed surveillance was spread only through the mass media, apart from the local signs at the test sections. Direct and unbiased information on the experiment was not available to the public.

Effects on road safety

The road safety analysis carried out with data on accidents and road casualties notified by the police both for the test sections and control sections shows that the total number of personal injury accidents and the number of casualties decreased from the "before period" to the test period on both the test sections and control sections.

The decrease in the number of personal injury accidents was 22 % on the test sections and 17 % on the control sections. The number of road casualties decreased by 28 % on the test sections and by 21 % on the control sections.

Because of the limited numbers of personal injury accidents and road casualties the positive safety effect from automatic speed surveillance, as estmated reduction of the number of injury accidents by 5 % and a reduction of the number of caualties by 9 %, for the experiment as a total is not statistically significant.

Speed Research and Current Issues at the National Level in USA

1. INTRODUCTION

This report is based on discussions on 14 October, 1992 at the National Highway Safety Administration (NHTSA) with:

Noble Bowie	- NHTSA
Carl Nash	- NHTSA
Clay Hall	- Office of Enforcement, NHTSA
Sam Tignor	- Federal Highway Administration
Donald Bischoff	- Associate Administrator, NHTSA

and on 15 October with Brian O'Neill, President, Insurance Institute for Highway Safety (IIHS). The discussions were intended to be on all aspects of speed research and speed management, but it was found that there was generally a pre-occupation with the increased 65 mph rural interstate limit Literature obtained as a result of these discussions has also been studied.

2. THE 65 MPH LIMIT

2.1 Background

In January 1987, the US Congress passed the Surface Transportation and Uniform Relocation Assistance Act (1987), amending the Emergency Highway Energy Conservation Act (1974), which had originally set the national maximum speed limit (NMSL) at 55 mph (88 km/h). This new Act, which allows States to raise speed limits on rural interstate freeways up to 65 mph, came into effect in April 1987.

By the end of 1987, 38 States had raised their speed limit on interstate rural freeways to 65 mph and two more States did so in 1988. In addition 20 States were participating in NHTSA's demonstration programs in which speed limits on selected rural highways which are of similar standard to rural interstate freeways were raised to 65 mph

2.2 Effect of 65 mph limit

There has been a large number of evaluations of the effect of increasing the 55 mph speed limit on rural interstates to 65 mph, some examining the effect in a single State, others combining the effect in many States. For example, Wagenaar et al use a multiple time series design comparing roads where the speed limit was raised with those where the limit remained unchanged in Michigan. Time series intervention analyses were conducted. Controls were included for major factors known to influence crash and injury rates. They found for 1988, significant increases in casualties on these 65 mph roads with a 19.2% increase in fatalities, a 39.8% increase in serious injuries and a 25.4% increase in moderate injuries. (Wagenaar et al, 1990). Garber and Graham conducted separate analyses for each of the 40 States which had adopted the 65 mph limit. Time series multiple regression equations - including policy variables, seasonal variables and surrogate exposure variables were estimated for each State using monthly fatality data from 1976 and November 1988. They found increased fatalities on both rural interstates (median increase 15%) and rural non-interstate highways in most States, although the effects differed considerably across States (Garber and Graham, 1989).

In another study, Baum et al found that in 1989 among the 40 States with increased speed limits the number of fatalities was 29% higher than expected from trends during 1982-86 After adjusting the fatality risk for differences in vehicle miles travelled and higher vehicle occupancy rates, the increased fatality risk was 19% (Baum et al, 1989)

A collection of some 70 abstracts on the relationship between speed and crashes which was prepared for the Transportation Research Board is attached to provide further information (Transportation Research Board Information Services, 1992).

Godwin has recently reviewed a number of the above studies and others. He found that while there are differences between the studies of the national effects, they generally point to the same direction, and most found significant increases in fatalities associated with the 65 mph limit. He states the studies indicate that fatalities have increased on rural interstates by roughly 15-25% resulting in approximately 300-500 additional deaths on highways posted at 65 mph in 1988 There is some estimate that the higher speeds on 65 mph roads are spilling over to 55 mph rural interstates (Godwin, 1992 (a)).

Lave on the other hand, argued that system-wide effects should be measured to allow for:

1) Diversion of some traffic previously using less safe ordinary roads to the safer rural interstates because of the opportunity to driver faster;

2) Reallocation of enforcement efforts from rural interstates to policing more dangerous other roads.

Using Godwin's data, he then showed that for the group of States which raised their rural interstate speed limit, their statewide fatality rate declined about 6% while that for the 55 mph States was about the same (Lowe, 1992). Godwin then responded that the shift in traffic to the 65 mph rural interstates to achieve these lower fatality rates would have represented a 70% increase in vehicle miles travelled, whereas there was only a 14.8% shift in these States (Godwin, 1992 (b)).

In its most recent Report to Congress on the "Effects of the 65 mph speed limit", the US Department of Transportation reported that in 1990 the 2,336 fatalities on rural interstates in the 38 States which increased their speed limits to 65 mph in 1987 were 30% greater than might have been expected from historical trends. However, because of increased traffic, the fatality rate for these roads had returned to their 1986 rate (1.4 fatalities per 100 million vehicle miles travelled). Furthermore the rural interstates for all States have only 6 percent of all fatalities and are the safest component of the nation's highway system (1.3 fatalities per 100 million vehicle miles compared to 2.1 for all roads) (National Highway Traffic Safety Administration, 1992). While not stated in that report, these facts provide a clear indication of the need to look beyond these 65 mph rural interstates to the roads which have the other 94% of fatalities.

Based on speed data available from only 18 of the 40 states with 65 mph limits, average travel speeds have increased from 60.6 mph in the last quarter of 1986 to 64.0 in the last quarter of 1990, i.e. from 5.6 mph above the posted limit to 1 mph below in 1990. However the percent exceeding 70 mph has increased from approximately 6 percent when the posted limit was 55 mph to 19 percent in 1990, when the posted limit was 65 mph.

3. SPEED ENFORCEMENT

It was pointed out that enforcement is an integral part of any program to reduce speed related crashes. A wide range of research activities and demonstration projects has been initiated by National Highway Traffic Safety Administration in co-operation with various States These are described in the Speed Enforcement Program Plan report to Congress (National Highway Traffic Safety Administration, 1991) Some of these are summarised below.

3.1 Public Information and Education

In recognition of the lack of public awareness of the degrees of excessive speeding, the need for public information and education programs has been identified. The advantages of using publicity to heighten awareness of an enforcement program is also recognised

3.2 State/regional enforcement activities

A number of special enforcement programs are being undertaken in individual States or groups of States to cover particular interstate routes or arterial corridors within a State

3.3 Workshops and training

Workshops to provide assistance to State and local law enforcement departments have been held in many States. Training resources have been provided for police.

3.4 Automatic speed enforcement devices

Photo radar trials are being conducted in a number of localities. Demonstration projects in several States are being undertaken Evaluation of various types of equipment have included laser speed measurement devices and radar operated speed signs.

3.5 Research

Research is being undertaken to determine whether traffic enforcement activity can have an effect on the extent of criminal activity. Other research is examining the effect of a combined enforcement program aimed at speed, alcohol and safety belt use.

Longer term research is planned which will include efforts to:

"• Determine when, where and under what conditions specific speeds or other unsafe driving actions should be considered dangerous;

- Determine what motivates the driving public to speed or commit other unsafe driving actions and what can be done to convince the public that certain speeds or other unsafe driving actions under certain conditions are hazardous;

- Develop model enforcement strategies that effectively target speeding or other unsafe driving actions and raise the public's perception of detection and apprehension risk;

- Develop guidelines for setting speed limits for dangerous and non-dangerous traffic situations."

4. CONCLUSION

There appears to be a general view amongst government officials that as the decision on the 65 mph speed limit for rural interstate freeways has been made, attention should now turn to other areas of speed management and research. In particular, there is scope for working with State agencies to improve speed enforcement throughout the road network and public understanding of speed management issues.

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Godwin, S.R , 1992 (a) 'Effect of the 65 mph speed limit on highway safety in the USA (with comments and reply to comments)', *Transport Reviews*, Vol 12, No. 1, pp 1-10

Godwin, S.R., 1992 (b) 'Reply to Charles Lave's comments on: "Effect of the 65 m.p.h. speed limit on highway safety in the U S.A "', *Transport Reviews*, Vol 12, No. 1, pp 13-14.

Lave, C. 1992 'Comment on Stephen R. Godwin's "Effect of the 65 m.p.h. speed limit on highway safety in the U.S.A."', *Transport Reviews*, Vol 12, No 1, pp 11-13.

National Highway Traffic Safety Administration, 1992 *Effects of the 65 mph speed limit through 1990; a report to Congress May 1992,* US Department of Transportation, National Highway Traffic Safety Administration, DOT-HS-807 840

National Highway Traffic Safety Administration, 1991 *Speed Enforcement Program Plan; a report to Congress March 1991,* US Department of Transportation, National Highway Traffic Safety Administration, DOT-HS-807 730

Transportation Research Board, 1992 *The relationship between speed and crashes,* citations from Transportation Research Information Services (TRIS) database prepared for Session 182, The relationship between speed and crashes, of the 71st Annual Meeting of the Transportation Research Board

Wagenaar, A.C., Streff, F M. & Schultz, R.H., 1990 'Effects of the 65 mph speed limit on injury morbidity and mortality', *Accident Analysis and Prevention.* Vol 22, No 6, pp 571-585.

THE RELATIONSHIP BETWEEN SPEED AND CRASHES

Prepared for
Session 182,
The Relationship Between Speed and Crashes,
of the
71st Annual Meeting of the
Transportation Research Board
Wednesday, January 15, 1992

Prepared from the
Transportation Research Information Services
(TRIS)
Database
A Service of the
Transportation Research Board

TRB

490743 DA
100-KM/H-SPEED LIMIT ON GERMAN AUTOBAHNS AND ITS EFFECTS ON ACCIDENTS
Marburger, EA; Meyer, L; Ernst, R
Federal Institute of Road Research, West Germany Bruhlerstrasse 1, Postfach 510530 D-5000 Cologne 51 West Germany
Sep 1986 31p Tabs. 5 Ref.
REPORT NO: HS-040 377
SUBFILE: HSL
AVAILABLE FROM: Federal Institute of Road Research, West Germany Bruhlerstrasse 1, Postfach 510530 D-5000 Cologne 51 West Germany
The details are described and the results are presented of a study of accidents on selected autobahn stretches in 1984 and 1985 based on a total of about 6,000 accidents involving casualties and/or serious damage. A comparative method of study was used, and 3 types of comparisons were used. It was found that on all individual stretches, the number of all accidents on test stretches dropped by 23.2% and on the control stretches (without speed limit) by 6.7. By a corresponding statistical test method, the effectiveness of the measure has been calculated at 17% and statistically ascertained at the 95% level. The study results are discussed in detail.

475562 DA
65 M.P.H.: IS THE JURY STILL OUT?
Plous, FK, Jr
National Safety Council
Traffic Safety VOL. 88 NO. 4 Jun 1988 pp 6-10
SUBFILE: HRIS
AVAILABLE FROM: National Safety Council 444 North Michigan Avenue Chicago Illinois 60611
A year after states were permitted to raise their speed limits to 65 m.p.h. on rural Interstates, safety officials are sorting through the accident figures to determine if the change was as dangerous as critics predicted, or as benign as advocates promised. Authorities in several states with higher Interstate speed limits are noting a disturbing ncrease in accident rates. Some states noted that motorists were exercising the higher speed prerogative even before it went into effect. It is also thought that there is a spillover effect of the higher limits on non Interstate highways. The U.S. Department of Transportation notes that although it is too early to tell whether the new speed limit was having an effect, there was a 20% increase in traffic deaths in the first 28 states that raised the limit. In Missouri, fatalities increased while overall accidents remained stable, leading to the conclusion that speed was probably the reason. Some have attributed this to the increasing number of pickups which are exempt from the state's seat belt law. Critics of the 55 mph limit cite California's experience, but others point out that California's statistics are insufficient. To restore the 55 mph speed limit, it will be necessary to mount a public informaton campaign focused on the life-saving aspect of the lower speed limit.

608691 DA
65 MPH DEBATE CONTINUES
Capelle, RB, Jr
Regular Common Carrier Conference, ATA
Transportation Executive Update VOL. 3 NO. 5 Sep 1989 p 46
SUBFILE: HRIS
AVAILABLE FROM: Regular Common Carrier Conference, ATA 2200 Mill Road, Suite 350 Alexandria Virginia 22314-4677
Arguments for and against the 65 mph speed limit for rural interstate highways are presented. The author discusses a report released in January 1989 by the National Highway Traffic Safety Administration (NHTSA), as well as debate raised on the issue at the 1989 annual meeting of the Transportation Research Board. The article also includes information on university research being conducted on the impact of a 65 mph speed limit on accident fatalities. The article also includes discussion of research in the trucking industry and the 65 mph question; and the reasons why the controversy surrounding this issue will not easily dissipate.

554258 DA
65 MPH: WINNERS AND LOSERS
Miller, TR
US Dept of Transportation National Highway Highway Traffic Safety Administration Washington DC
Jul 1989 Final Report 25 pp
REPORT NO: DOT HS 807 451
CONTRACT NO: DTNH22-88-Z-37192.
SUBFILE: UCITS; TLIB
Available From the National Technical Information Service Springfield, VA
No abstract available.

336519 DA
A NATIONAL SURVEY OF DRIVERS' ATTITUDES AND KNOWLEDGE ABOUT SPEED LIMITS
Mostyn, BJ; Sheppard, D
Transport and Road Research Laboratory Road User Characteristics Division, Old Wokingham Road Crowthorne RG11 6AU Berkshire England; Cranfield Institute of Technology School of Management, Marketing Communications Res Centre Cranfield Bedford MK40 0AL England
1980 35p 11 Refs.
REPORT NO: SR-548; HS-030 869
SUBFILE: NTIS, HSL
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161
The introduction of a speed limit or increases in enforcement of speed limits can lead to reductions in accidents. Nevertheless, it seems that a large proportion of motorists break speed limits sometimes, and this report describes a survey among drivers to examine why this occurs The survey was conducted in 1976. The study confirms some pilot research which showed that many motorists are not fully aware of how to recognize what speed limit applies to a stretch of road. Speed limits had been changed several times prior to the time of the survey, and this survey showed that many motorists were not aware of the speed limits which applied at that time. Motorists seem to think that speed limits are useful as guidelines and few feel that motorists should be left to decide appropriate speeds for themselves. Motorists favor quite severe punishments for those who exceed speed limits by 20 mile/h, particularly at the higher limits. Some 44 per cent of motorists say they do not wish to see speed limits changed. Some data are presented on which type of driver favors or disapproves of limits and some suggestions are made about ways in which knowledge might be increased about limits and where they apply. (Copyright (c) Crown

Copyright 1980.) Also pub. as ISSN-0305-1315.

603046 DA

ACCIDENTS BEFORE AND AFTER THE 65 MPH SPEED LIMIT IN CALIFORNIA (SUPPLEMENTAL REPORT). FINAL REPORT

Smith, RN

California Department of Transportation Division of Traffic Operations, 1120 N Street Sacramento California 95814

Oct 1990 38p 12 Fig. 6 Tab. 4 Ref.

REPORT NO: CA-TO-90-4; 51358-908074-30062

SUBFILE: HRIS

AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161

A question of current interest is whether raising the speed limit from 55 mph to 65 mph on rural interstate freeways increased fatal accidents or not. The limit was raised on 1,155 miles of California interstate freeways about June 1, 1987. The speed limit was retained at 55 mph on the remaining 343 miles. Also, the limit was raised on 132 miles of rural "look-alike" freeway about June 1, 1988. This report analyzes fatalities, fatal accidents, and injury accidents before and after the speed limit change. Two years of after data, along with an estimated third year of accidents and travel, were available for the rural interstate analyses; one year, along with an estimated second year, were available for the "look-alike" analyses. Travel increased more on the interstate routes raised to 65 mph than on other state highways. Fatal accident rates had been increasing since 1982, long before the speed limit change, on the rural interstate routes. The rate of increase has remained unaltered since the limit was raised to 65 mph. It is concluded that raising the speed limit to 65 mph on rural interstate routes did not increase fatal and injury accidents, when traffic volume changes and preexisting accident rate trends are accounted for. Also, there were no significant changes in fatal and injury accident rates on interstate routes where the speed limit was retained at 55 mph. There were, on the other hand, apparent increases in fatal accidents on the "look-alike" route. This should receive further analysis and investigation.

610628 DA

ANALYSIS OF SPEED AND OTHER UNSAFE DRIVING ACTS

Streff, FM; Schultz, RH; Molnar, LJ

University of Michigan Transp Research Institute 2901 Baxter Road Ann Arbor Michigan 48109-2150

Mar 1990 77p

REPORT NO: UMTRI-90-11

SUBFILE: HRIS

AVAILABLE FROM: University of Michigan Transp Research Institute 2901 Baxter Road Ann Arbor Michigan 48109-2150

The objective of this project is to support the development of effective enforcement strategies to reduce crashes resulting from speeding and other unsafe driving acts associated with speeding. A census dataset of crash-involved traffic units from 11 states was built for the analyses. The 11-state data-set had a total of 3,421,258 crash-involved traffic units available for analysis, of which 1,905,179 had at least one unsafe driving act (UDA) recorded (55.7%). Speed was coded as a contributing factor in 337,440 of the cases. A second UDA was coded in addition to speeding in 103,300 of the cases in which speed was coded. The condition probability of specific UDA being reported when speeding was also reported in a given crash is low. However, analyses of likelihood ratios of other UDAs occurring with speeding found excessive speed to be related to improper lane use, improper passing, driving the wrong way, driving left of center, driver inattention, and alcohol/drug involvement. We found little evidence to support the development or implementation of significant new strategies for deploying enforcement personnel or targeting and observing unsafe driving actions that contribute crashes. We did find evidence to support continuing efforts to enforce speed laws. In addition, we found evidence to support enhancing speed enforcement efforts on road segments with an uphill or downhill grade or curved road segments by having officers also be alert for drivers who may be exhibiting general improper lane use or specifically, vehicles driving left of center.

496437 PR

ANALYSIS OF SPEED AND UNSAFE DRIVING ACTS

INVESTIGATORS: Streff, F

SPONSORING ORG: National Highway Traffic Safety Administration

PERFORMING ORG: University of Michigan Transp Research Institute 2901 Baxter Road Ann Arbor Michigan 48109-2150

PROJECT START DATE: 8909

PROJECT TERMINATION DATE: 9012

SUBFILE: HRIS

The objective of this project is to support the development of more effective enforcement strategies to reduce crashes resulting from speeding and other unsafe driving acts associated with speeding. This objective will be achieved by two goals: (1) determining the associations between speeding and other unsafe driving acts, and (2) suggesting more effective strategies based on relationships between speed and other unsafe driving acts. This contract will be conducted in three phases. The goal of the first phase is to identify unsafe driving acts which are related to speeding based on available literature and analyses of existing data. A feasibility analysis will be conducted during the second phase to determine realistic requirements necessary to conduct and complete "on the road" observations of unsafe driving acts. In the third phase an observational study of driving behavior will be conducted to verify relationships between speeding and other unsafe acts identified in the first phase.

477313 DA

ANALYSIS OF SPEED ZONING EFFECTIVENESS. FINAL REPORT

Taylor, WC; Coleman, F, III

Michigan State University, East Lansing Department of Civil and Environmental Engineering East Lansing Michigan 48824; Michigan Department of Transportation State Highways Building, 425 West Ottawa, P.O. Box 30050 Lansing Michigan 48909; Federal Highway Administration 400 7th Street, SW Washington D.C. 20590

Apr 1988 50p Tabs. 24 Ref. 3 App.

REPORT NO: FHWA-MI-RD-88-01

CONTRACT NO: 0010 (10); HP&R

SUBFILE: HRIS

AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161

This study was undertaken to determine if the procedure used to establish the speed limit in speed zones on the Michigan State Trunkline System results in a significant savings in accidents An additional objective was to determine if specific speed distribution characteristics, enforcement levels, or environmental and geometric factors are related to the reduction in accidents within speed zones. Twenty speed zones established in 1982 and 1983 were analyzed. There is no evidence that the current procedure of using the 85th percentile of observed speeds is inappropriate from a safety perspective. In fact, the aggregate reduction in accidents in these twenty zones (when compared to control sites) was statistically significant. On an individual zone basis, nine of the twenty zones showed a reduction in accidents, three showed an increase in accidents and the remaining eight zones either showed no change or the number of accidents was too small to conduct an analysis. Four of the nine zones in which accidents were reduced demonstrated a statistically significant reduction in accident frequency.

495477 DA
ARIZONA'S EXPERIENCE WITH THE 65-MPH SPEED LIMIT
Upchurch, J
Transportation Research Board
Transportation Research Record N1244 1989 pp 1-6 14 Fig. 1 Tab.
SUBFILE: HRIS
AVAILABLE FROM: Transportation Research Board Publications Office 2101 Constitution Avenue, NW Washington D.C. 20418
Arizona's experience with the 65-mph speed limit is presented in terms of driver behavior and accident experience. The speed limit on Arizona's rural interstate was raised to 65 mph on April 15, 1987. Driver behavior is presented in terms of the speeds at which motorists actually drive on the rural interstate. Before and after data are presented from the last quarter of 1983 through the first quarter of 1988. Vehicle speeds increased by only about 3 mph or less during the four quarters following the speed limit increase. A 5-year history of interstate accident data--from 1983 through spring 1988--is presented that provides a before-and-after comparison. Information on total accidents, fatal accidents, and injuries is presented. Accident rate information is presented to account for the effect of increasing vehicle-miles of travel. Accident data on the urban interstate are presented for comparison purposes. This paper appears in Transportation Research Record No. 1244, Traffic and Grade Crossing Control Devices.

603695 DA
ASSESSMENT OF CURRENT SPEED ZONING CRITERIA
Harkey, DL; Robertson, HD; Davis, SE
Transportation Research Board
Transportation Research Record N1281 1990 pp 40-51 9 Fig. 14 Tab. 6 Ref.
SUBFILE: HRIS
AVAILABLE FROM: Transportation Research Board Publications Office 2101 Constitution Avenue, NW Washington D.C. 20418
As early as 1947, studies concluded that the majority of drivers ignore speed limits and drive at speeds that they believe are safe and reasonable. Since then, some studies have supported this conclusion whereas others indicated that speed limits do affect travel speeds in varying degrees. In an FHWA-sponsored assessment of current speed zoning criteria, speed and accident data were collected at 50 locations, both urban and rural, in four states on roadways with posted speed limits ranging from 25 to 55 mph. These data were analyzed to determine travel speed characteristics, compliance with posted speed limits, and the point of minimum accident risk. Significant findings were as follows: Mean speeds exceeded posted speed limits by 1 to 8 mph; 85th-percentile speeds ranged from 6 to 14 mph over the posted speed limit, or 4 to 7 mph over the mean speed; the majority (70.2%) of free-flow drivers observed did not comply with posted speed limits; in general, 85% compliance was achieved at speeds 10 mph over the posted speed limit; accident rates for the 25-mph zones were consistently much higher than for any of the other zones; and the speed at which accident risk was minimized occurred at the 90th percentile of the travel speeds observed. This paper appears in Transportation Research Record No. 1281, Human Factors and Safety Research Related to Highway Design and Operation.

608814 PR
AUGUMENTED COMPLIANCE EFFORT (ACE) III
INVESTIGATORS: Robertson, D
SPONSORING ORG: California Office of Traffic Safety
PERFORMING ORG: California Highway Patrol 2555 1st Avenue Sacramento California 95818
CONTRACT NO: PT9005; Contract
PROJECT START DATE: 8910
PROJECT TERMINATION DATE: ND
SUBFILE: HRIS
Project funds provide for personnel, travel, and public awareness campaign costs to augment the California Highway Patrol's existing speed enforcement program on 55 and 65 MPH highways. Project objectives are to raise the level of compliance with 55 and 65 MPH speed limits and reduce speed primary collision factor traffic accidents by increasing available work hours for enforcement efforts.

608815 PR
AUGUMENTED COMPLIANCE EFFORT (ACE) IV
INVESTIGATORS: Robertson, D
SPONSORING ORG: California Office of Traffic Safety
PERFORMING ORG: California Highway Patrol 2555 1st Avenue Sacramento California 95818
CONTRACT NO: PT9102; Contract
PROJECT START DATE: 9010
PROJECT TERMINATION DATE: ND
SUBFILE: HRIS
Project funds provide for personnel, travel, and public awareness campaign costs to augment the California Highway Patrol's existing speed enforcement program on 55 and 65 MPH highways. Project objectives are to raise the level of compliance with 55 and 65 MPH speed limits and reduce speed primary collision factor traffic accidents by increasing available work hours for enforcement efforts.

573403 DA
BEFORE SIXTY-FIVE?: AN ANALYSIS OF SPEED ON RURAL INTERSTATE FREEWAYS
Nakao, DK
California Dept of Transportation Division of Traffic Operations Sacramento
Aug 1989 Final Report 24 pp
REPORT NO: CALTRANS/TE/89-1
SUBFILE: UCITS; TLIB
No abstract available.

367624 DA

DEATH AND INJURY FROM MOTOR VEHICLE CRASHES IN ISRAEL: *EPIDEMIOLOGY, PREVENTION AND CONTROL*

Richter, ED (Hebrew University, Jerusalem)
Oxford University Press
International Journal of Epidemiology VOL. 10 NO. 2 1981 pp 145-153 9 Fig. 2 Tab. 29 Ref.
REPORT NO: HS-033 080
SUBFILE: HRIS; HSL
AVAILABLE FROM: *Oxford University Press Press Road, Neasden* London NW10 0DD England

Death and motor vehicle crash (MVC) rates per 1000 vehicles and kilometres travelled in Israel (1977) exceed those of all western countries, despite low numbers of young and intoxicated drivers. Increased casualties have resulted from expansion of driver and vehicle populations offsetting a decline in crash risk. Time data indicate casualty crash trends *reflect trends in traffic volume, and that* night time case fatality rates (CFR) are high. Place data indicate that more than three quarters of all crashes occur in cities, mostly involving pedestrians, but the majority of deaths result from higher speed inter-urban crashes, mostly of 2-vehicle type, and not at intersections. The rates for deaths per 100 crashes are 4- and 8-fold higher in inter-urban than urban crashes for occupants and pedestrians, respectively. Vehicle data indicate high *MVC risk from careless* driving, probably speeding in taxis, and point to the need for occupant protection standards in lightweight trucks and pickup vans. Human data indicate that 92% of drivers in MVCs are male. The risk of involvement is high for drivers aged 18 and drops at age 55. Pedestrian accidents resulted in 48.1% of all dead, and included large numbers of young and elderly. Reduction in inter-urban private motor vehicle travel and in speeds at which crashes occur are suggested as swift and effective measures to reduce death and injury. Low cost strategies include air bags and other occupant protection standards and more seat belts. Prevention of pedestrian accidents requires a variety of measures to reduce vehicle-pedestrian conflicts.

372684 DA

DEVELOPMENT AND EVALUATION OF THE CRASH (CALSPAN RECONSTRUCTION OF ACCIDENT SPEEDS ON THE HIGHWAY) 2 PROGRAM FOR USE UNDER EUROPEAN CONDITIONS

Jones, IS; Jennings, PW
Oxford University, England Oxford Road Accident Group Oxford OX2 6NB England
1980 14p 7 Ref.
REPORT NO: HS-030 748
SUBFILE: HSL
AVAILABLE FROM: IRCOBI-Secretariat 109 Avenue Salvador Allende 69500 Bron France

Of 200 British accidents investigated on the scene, 62% could be reconstructed with damage-only runs of the CRASH (Calspan Reconstruction of Accident Speeds on the Highway) program; 10.5% had insufficient data; 20% were sideswipe or loss of control/rollover accidents and could not be simulated. For 200 accidents studied retrospectively, *52% could be reconstructed, 8.5% had insufficient* data, and 33.5% were not applicable. Comparison with National Crash Severity Study data, which are representative of U.S. conditions, showed a similar success rate (about 50%) for CRASH reconstructions in follow-up investigations. A total of 38 car impact tests were used to obtain more accurate frontal crush stiffness coefficients for the minicar and subcompact categories, and four tests were made to explore the accuracy of the compact group. Difficulties in obtaining a realistic velocity change threshold for the onset of crush deformation necessitated weighting the optimization techniques, leading to a more realistic threshold but a slightly reduced closeness of fit to the individual data points. The trajectory analysis of CRASH was modified to accommodate yaw angles on impact, giving increased algorithm accuracy and utility. Published in HS-030 722, "International IRCOBI Conference on the Biomechanics of Impacts (5th) Proceedings," Amsterdam, 1980, pp 318-31. Conference held in Birmingham, England, 9-11 September 1980. Research sponsored by Transport and Road Research Laboratory (England).

474956 DA

EFFECT OF THE DRIVING ENVIRONMENT UPON VEHICLE SPEEDS IN RESIDENTIAL AREAS

Freeman, MJ
National Institute for Transport & Rd Res, S Af P.O. Box 395 Pretoria 0001 Transvaal South Africa 0-7988-3840-X
Nov 1985 32P
REPORT NO: RV/17
SUBFILE: HRIS; NTIS
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161

Through-traffic and speeding have been shown to be major contributors to accidents in residential areas. Through-traffic can be eliminated by the use of a structured road hierarchy, but the reduction of speeding has proved a more difficult problem to remedy *The aim of the pilot study was to investigate, by means of regression* analysis, factors that are thought to influence speed on residential roads. The study indicated that street length and width were the most important factors in determining speeds.

559398 DA

EFFECTS OF 65-MPH SPEED LIMIT ON TRAFFIC SAFETY

Chang, G; Paniati, JF
Journal of Transportation Engineering Vol. 116 No. 2 Apr 1990 pp 213-226
SUBFILE: UCITS; TLIB
No abstract available.

467854 DA

EFFECTS OF REDUCED SPEED LIMITS IN RAPIDLY DEVELOPING URBAN FRINGE AREAS (ABRIDGMENT)

Ullman, GL; Dudek, CL
Transportation Research Board
Transportation Research Record N1114 1987 pp 45-53 5 Tab 11 Ref. 1 App.
SUBFILE: HRIS
AVAILABLE FROM: Transportation Research Board *Publications* Office 2101 Constitution Avenue, NW Washington D.C. 20418

Speed zoning on the basis of the 85th percentile speed in rapidly developing urban fringe areas usually results in the posting of 55 mph speed limits. Although these areas have some urban-like characteristics, no differentiation in speed limits is made between highways in these areas and those in rural locations. Speed zoning below the 85th percentile may be beneficial to drivers in rapidly developing areas, indicating that the area requires additional attention and caution. Presented in this paper are the results of field studies conducted at six urban fringe highway sites in Texas where speed limits were currently 55 mph and rapid urban development was occurring. Speed zones of 45 mph were installed at these sites even though the 85th percentile speed did not warrant the lower speed zones. Spot speed, speed profile, and accident data were collected before and after the speed zones were implemented. No significant changes occurred in speeds, speed distributions, or speed-changing activity at the sites. Likewise, accident rates remained unchanged. It appears that the lower speed zones were not effective in improving safety at these sites. This paper appeared in Transportation Research Record No. 1114, Traffic Control Devices and Rail-Highway Grade Crossings.

361320 DA

EFFECTS OF SPEED LIMIT ALTERATIONS ON ROAD SAFETY

Koshi, M; Kashima, S (Tokyo University, Japan)
International Association of Traffic & Safety Sci
IATSS Research VOL. 5 1981 pp 6-15 8 Fig. 10 Tab. 5 Ref.
REPORT NO: HS-032 485
SUBFILE. HRIS; HSL
AVAILABLE FROM: International Association of Traffic & Safety Sci 6-20, 2-chome, Yaesu, Chuo-ku Tokyo 104 Japan

The Metropolitan Police Department has recently changed the speed limit from 40 km/hr to 50 km/hr on some arterial roads within Tokyo. We took this opportunity of conducting two analytical research projects on the relationship between driving speed and traffic accidents outbreak. The first one carried out is the analysis of accident outbreak conditions before and after the speed limit alterations made on several roads in 1978. The second one conducted is the comparative analysis on accident outbreak on the roads where the speed limit had been alterated and where it had not. From the results of those analyses, it was concluded that the speed limit alteration mentioned above resulted in an increase in driving speed but did not exert an unfavorable influence upon traffic accidents outbreak.

571835 DA

EFFECTS OF THE 65 MPH SPEED LIMIT ON INJURY MORBIDITY AND MORTALITY

Wagenaar, AC; Streff, FM; Schultz, RH
Accident Analysis and Prevention Vol. 22 No. 6 Dec 1990 pp 571-585
SUBFILE: UCITS; TLIB
No abstract available.

601588 DA

EFFECTS OF THE 65-MPH SPEED LIMIT ON RURAL INTERSTATE FATALITIES IN NEW MEXICO

Gallagher, MM, Sewell, N; Flint, S; Herndon, JL; Graff, N; Flenner, J; Hull, HF
American Medical Association
Journal of the American Medical Association VOL. 262 NO. 16 1989 pp 2234-45
SUBFILE: HRIS
AVAILABLE FROM· American Medical Association 535 North Dearborn Street Chicago Illinois 60610

The rates of fatal crashes before and after the speed limit changes were compared. The rate of fatal crashes in the year after the speed limit ws increased was 2.9 per 100 million vehicle miles, comparec with a predicted rate of 1.5 per 100 million vehicle miles based on the trend of the 5 previous years. When fatal crashes that ocurred after the speed limit change were compared with fatal crashes in the 5 previous years, there was no difference in the mean age and sex of the at-fault drivers, mean age and sex of the victims, seat belt use by the victims, or alcohol involvement of the crashes. The increase in fatal crshes can be attributed to an increase in fatal single-vehicle crashes Vehicles on rural interstates are traveling at greaater rates of speed and a larger proportion of vehicles are exceeding the 65 mph speed limit. The benefits associatied with the 65 mph speed limit should be weighed against the increased loss of lives.

482684 DA

EVALUATING THE 65 MPH SPEED LIMIT; RESEARCH DESIGN AND BASELINE DATA

Wagenaar, AC; Streff, FM; Schultz, RH
University of Michigan Transp Research Institute 2901 Baxter Road Ann Arbor Michigan 48109
Sep 1988 66p
REPORT NO: UMTRI-88-27
SUBFILE: HRIS, NTIS
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161

The interim report on the effect of Michigan's increase in speed limit to 65 mph on limited access highways summarizes activity during the first year of a two-year project. The authors: (1) review national and Michigan experience with the 55 mph speed limit; (2) present methods to be used to determine effects of the recent increase to 65 mph; and (3) describe patterns in 1978-86 crash, speed, and VMT data. In the project's second year they will: (1) update database and time-series files with 1987 and 1988 calendar year data, (2) develop time-series models for each outcome variable; (3) compare observed effects across road segmentws with varying speed limits, (4) examine speed limit effects by age, sex, number and type of vehicles involved in the crash, vehicle damage severity, injury severity, and whether speed was reported to be a contributing factor to the crash, and (5) provide recommendations regarding speed limits on rural highways in light of project findings. See also PB85-234466.

607640 DA

EVALUATION OF THE NEW YORK STATE POLICE 55 MPH SPEED ENFORCEMENT PROJECT. FINAL REPORT

McCartt, AT; Rood, DH
State University of New York, Albany Institute for Traffic Safety Management and Research Albany New York 12210, National Highway Traffic Safety Administration 400 7th Street, SW Washington D.C. 20590
Aug 1989 137p Figs. Tabs. 7 App.
REPORT NO: HS-807 618
CONTRACT NO DTNH22-88-Z-05037; Contract
SUBFILE: HRIS; HSL
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161

In response to increasing highway speeds, the New York State Police undertook a comprehensive speed enforcement program focusing on interstates in the upstate region of New York. A special target was "professional speeders", drivers who exceed the speed limit by the widest margins and are able to evade the police through the use of radar detectors and CB radios. The project provided for a structured implementation of ten different innovative and more traditional enforcement strategies and a comparison of the effectiveness and productivity of the strategies. In addition, the impact of increased speed enforcement on vehicle speed and crashes was assessed. Speeders tended to be male, under 35 years of age and driving passenger vehicles. In general, the strategies, such as aerial enforcement, that did not use radar were more effective and productive with professional speeders than strategies using radar. The exception was the single-Trooper radar operation called routine enforcement. Although the strategies involving the airplane had higher costs per ticket, such other benefits as general deterence effects, should also be considered. The cost per ticket of even the most expensive strategy was still much less than the average fine collected from speeders. The results of the project indicate that the State Police were successful in targeting professional speeders and that this success was reflected in decreasing numbers of drivers traveling at the highest rates of speed, and ultimately in reductions in the number of fatal crashes and in the number of fatalities and serious injuries suffered.

492058 DA

FACTORS AFFECTING SPEED VARIANCE AND ITS INFLUENCE ON ACCIDENTS

Garber, NJ; Gadiraju, R

Transportation Research Board

Transportation Research Record N1213 1989 pp 64-71 6 Fig. 6 Tab. 7 Ref.

SUBFILE: HRIS

AVAILABLE FROM: Transportation Research Board Publications Office 2101 Constitution Avenue, NW Washington D.C. 20418

One of the major factors that should be considered in selecting the speed limit for a stretch of highway is safety. It is generally accepted that the level of safety depends on certain characteristics of the traffic stream and the geometric alignment of the highway. However, in many cases speed limits are posted without adequate consideration given to these characteristics. For example, an important traffic characteristic that influences safety is speed variance. Currently, little is known about the factors that affect the variance of vehicle speeds in a traffic stream. Presented in this paper are the results of a study that investigated the influence of different traffic engineering factors on speed variance and quantified the relationship between speed variance and accident rates. A major influence on speed variance is the difference between the design speed and the posted speed limit. It was determined that speed variance will approach minimum values if the posted speed limit is between 5 and 10 mph lower than the design speed. Outside this range, speed variance increases with an increasing difference between the design speed and the posted speed limit. It was also found that drivers tend to drive at increasing speeds as the roadway geometric characteristics improve, regardless of the posted speed limit, and that accident rates do not necessarily increase with an increase in average speed but do increase with an increase in speed variance. This paper appears in Transportation Research Record No. 1213, Human Performance and Highway Visibility: Design, Safety, and Methods.

485756 DA

FATAL ACCIDENTS ON THE RURAL INTERSTATES OF SOUTH CAROLINA: EFFECTS OF THE SPEED LIMIT INCREASE

South Carolina Dept of Highways and Public Transp 955 Park Street, Drawer 191 Columbia South Carolina 29202

Mar 1988 11p 5 Tab. 5 Ref.

SUBFILE: HRIS

AVAILABLE FROM: South Carolina Dept of Highways and Public Transp 955 Park Street, Drawer 191 Columbia South Carolina 29202

A study was conducted in South Carolina of the fatal accident data for the period July 17, 1987 through December 31, 1987 on the rural interstate highways. The speed limit at this time was 65 mph. The data were compared with the same period in 1986 when the speed limit was 55 mph. The leading probable cause of fatal rural interstate accidents in both six month periods was running off the road. This occurred in 7 out of the 15 accidents in 1986 and in 6 out of 21 for 1987. In 1986 the majority of vehicles (57.9%) involved in fatal accidents were driven at speeds under 55. For 1987, 43.6% of the vehicles were traveling at speeds less than 55, with another 35.9% traveling between 56 and 65 mph. The number of fatal accidents as a percentage of all fatal accidents increased from 3.0% in the 1986 period to 4.0% in the 1987 period. Using three statistical inference techniques, this increase was shown not to be statistically significant.

479149 DA

HIGHWAY SAFETY AND THE 65 MPH MAXIMUM SPEED LIMIT: AN EMPIRICAL STUDY

McCarthy, PS

AAA Foundation for Traffic Safety 1730 M Street, NW, Suite 401 Washington D.C. 20036

Oct 1988 66p 7 Fig. 13 Tab. Refs. 1 App.

SUBFILE: HRIS

AVAILABLE FROM: AAA Foundation for Traffic Safety 1730 M Street, NW, Suite 401 Washington D C. 20036

A federal Highway Bill, enacted in April 1987, permitted states to raise the maximum speed limit on most rural interstate highways to 65 mph. The state of Indiana reacted promptly to the enabling legislation and, on June 1, 1987, raised the maximum speed limit on rural interstate highways in Indiana to 65 mph. This report presents the results of an analysis of extensive accident, speed, and other data relevant to highway safety that were collected from various Indiana state agencies for the period 1981-1987. The data were used to estimate statistical models of the incidence and severity of highway accidents. The basic finding from this analysis is that, during the first seven months in the post law environment, higher rural interstate speed limits in Indiana had very litte effect on interstate highway safety.

607605 DA

IMPACT OF DIFFERENTIAL SPEED LIMITS ON HIGHWAY SPEEDS AND ACCIDENTS

Garber, NJ; Gadiraju, R

Virginia University Department of Civil Engineering Charlottesville Virginia 22904; AAA Foundation for Traffic Safety 1730 M Street, Suite 401 Washington D.C. 20036

Jan 1991 58p 2 Fig. 18 Tab. 6 Ref. 3 App.

SUBFILE: HRIS

AVAILABLE FROM: AAA Foundation for Traffic Safety 1730 M Street, Suite 401 Washington D.C. 20036

Some states that have raised the speed limit on rural interstate highways from 55 mph to 65 mph, following enactment of the Surface Transportation and Uniform Relocation Assistance Act in 1987, have restricted truck speeds by imposing Differential Speed Limits (DSL), in which the maximum speed limit for trucks is 55 mph and that for passenger cars is 65 mph. The purpose of this study was to assess the nature and extent of the effects of DSL on vehicle speeds and accident characteristics. Before and after data at test and control sites operating under DSL and non-DSL conditions were statistically analyzed to determine whether speed and accident characteristics changed significantly as a result of the higher speed limit with DSL. Briefly, some of the findings were as follows. In states where DSL was imposed, there was no significant increase in the mean speeds of trucks. The DSL caused an increase in the average speeds of passenger cars of about 1 to 4 mph. Speed fluctuations within the non-truck traffic stream decreased. Speed variances for all vehicles were higher on Virginia highways with DSL (65/55 mph) when compared with those for similar highways in West Virginia operating under 65/65 mph No significant reduction in the rate of non--truck/truck accidents, or any two-vehicle accidents, occurred with DSL, compared with those on highways operating with 65/65 mph. There was no evidence indicating that the increase of the maximum speed limit to 65 mph for passenger cars on the rural interstate systems in the states studied has directly resulted in a significant increase in fatal, injury and overall accident rates. Rear-end accidents were relatively higher in Virginia than in West Virginia, suggesting that the DSL caused more rear-end accidents especially between cars and trucks. The rate of two-vehicle accidents reduced by a larger amount in West Virginia after the implementation of the 65/65 mph strategy, than in Virginia after the implementation of the 65/55 mph strategy.

394920 DA

INCREASE OF TRAFFIC SAFETY BY SURVEILLANCE OF SPEED LIMITS WITH AUTOMATIC RADAR DEVICES ON A DANGEROUS SECTION OF A GERMAN AUTOBAHN: A LONG-TERM INVESTIGATION

Lamm, R; Kloeckner, JH (Clarkson College of Technology, New York)

Transportation Research Board

Transportation Research Record N974 1984 pp 8-16 15 Fig. 2 Tab. 4 Ref.

SUBFILE: HRIS; HSL

AVAILABLE FROM: Transportation Research Board Publications Office 2101 Constitution Avenue, NW Washington D.C. 20418

Experiences in the Federal Republic of Germany have indicated that the introduction of speed limits often has only a short-term effect on reducing speeds, and consequently the number of accidents, unless police regularly enforce the speed limits. Posted speed limits alone will not guarantee compliance. Only when backed up by strict police enforcement can speed limits both reduce speed and alleviate accidents. To examine the influence of speed limits by strict surveillances by police, one of the most dangerous downgrade Autobahn sections in the Federal Republic of Germany was equipped with lanerelated radar devices and additional DO NOT PASS signs for trucks. The results of a long-term investigation from 1970 to 1982 are as follows: (a) in 1971 the design speed was exceeded by most of the passenger cars in the left and middle lanes, whereas in 1981 few passenger cars exceeded the speed limit in either lane; (b) the 85th percentile speeds were reduced in all lanes for passenger cars and trucks, and a more uniform traffic flow was noted; (c) the accident frequency, as related to personal injury, was reduced by a ratio of 18:1 between 1971 and 1981, and the number of fatalities dramatically decreased; and (d) between 1974 and 1983 a total of 30 million German marks was paid in fines. The experiences have demonstrated that the common impact of reasonable lane-related speed limits and strict surveillance by police with automatic radar devices has had a decisively positive influence on driving behavior and accident reduction. The investigation period of more than 10 years appears to be long enough to verify that the improvements are permanent. This paper appeared in Transportation Research Record Number 974, Police Traffic Enforcement and Alcohol Countermeasures.

469071 DA

INTERIM REPORT ON THE SAFETY CONSEQUENCES OF RAISING THE SPEED LIMIT ON RURAL INTERSTATE HIGHWAYS

National Highway Traffic Safety Administration 400 7th Street, SW Washington D.C. 20590

May 1988 88p Tabs.

SUBFILE: HRIS

AVAILABLE FROM: National Highway Traffic Safety Administration 400 7th Street, SW Washington D.C. 20590

A study is reported which is the first attempt to assess the effects of speed limits on highway safety. The study employs several analytical techniques. One approach compares the crash experience on rural Interstates before and after introduction of the 65 mph speed limit and examines differences between states that increased speed limits and those that did not. As background for these comparisons, rural Interstate fatalities, as well as fatalities on other road systems over the period 1982-1987, are presented. An assessment of changes in the nature of rural Interstate crashes is presented. To complement the comparisons made in the study, a mathematical model using 12 years of fatality data was developed. The model estimates 1987 rural Interstate fatalities based on the historical relationship between rural Interstate fatalities and fatalities on other highways. The model was used to estimate 1987 rural Interstate fatalities in the first 28 states that raised the speed limit. The estimated fatalities are compared with the actual fatality experience after the speed limit was raised. The 9 sections of this report give details of the study.

475401 DA

INVESTIGATION OF THE EFFECTS OF TEMPORARY SPEEDS OF 100 KM/HOUR ON SECTIONS OF MOTORWAYS IN THE CONTEXT OF THE LARGE EXHAUST GAS EXPERIMENT, ON THE OCCURRENCE OF ACCIDENTS

Marburger, EA; Meyer, L; Ernst, R

Federal Institute for Road Research, West Germany Bereich Unfalforschung Bergisch Gladbach West Germany

Sep 1986 50p German

SUBFILE: HRIS; NTIS

AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161

Large scale experiments were carried out on behalf of the West German Govrnment on parts of the motorway network for one year, with the aim of determining the effect of limiting the speed to 100 km/hour on the occurrence of accidents to private cars. There were limitations due to the relatively short sections examined. There are reports on the selection of comparative and control sections, the accident characteristics found and the method of examination. The results of examinations are submitted on the occurrence of accidents on individual sections, changes to the number of all accidents with personal injuries and serious material damage (differentiated consideration). One is also concerned with the connection of knowledge of accident analysis with the rearrangement problems. It is estimated that as a consequence of the 120/100 km/hour alternative, the number of accidents would decrease by about 1400 at 100/80 km/hour by about 14,000/18,000.

361926 DA

MANAGING THE SPEED CRASH RISK

Ruschmann, PA; Joscelyn, KB; Treat, JR

Highway Safety Research Institute Huron Parkway and Baxter Road Ann Arbor Michigan 48109

Oct 1981 52p Figs. Tabs.

REPORT NO: UM-HSRI-81-49; HS-032 710

SUBFILE: HRIS; HSL

AVAILABLE FROM: Highway Safety Research Institute Huron Parkway and Baxter Road Ann Arbor Michigan 48109

The driving error of improper speed has been identified as a leading cause of traffic crashes and associated losses. Excessive speed is particularly prevalent in fatal and other serious crashes. Society has taken formal action to control the crash risk posed by speeding; the earliest such response and the one most used today is the legal approach that rests on the concept of deterrence. In most jurisdictions criminal or criminal-like procedures are used to enforce speeding laws: police officers are deployed to observe for speeders; suspected violators are pursued and apprehended; and offenders are referred to judicial or administrative tribunals to determine guilt or innocence. A variety of patrol configurations, vehicles, and speed-measuring devices (chiefly radar) are used by police agencies to enforce speeding laws. Speed enforcement as currently carried out is labor intensive and costly, principally because legal requirements stemming from the use of criminal law and procedures must be followed. For traditional enforcement procedures to effectively deter speeding, large increases in funds and personnel would be required. Therefore, strategies other than the legal approach for managing the speed crash risk should be considered.

602595 DA

MOTOR VEHICLE CRASH FATALITIES AND 65 MPH SPEED LIMITS ON RURAL INTERSTATES IN 40 STATES

Lund, AK; Wells, JK; Baum, HM

Insurance Institute for Highway Safety 1005 North Glebe Road Arlington Virginia 22201

Aug 1989 4p 3 Tab. Refs.

SUBFILE: HRIS

AVAILABLE FROM: Insurance Institute for Highway Safety 1005 North Glebe Road Arlington Virginia 22201

The purpose of this study was to estimate the effect of 65 mph speed limits in all 40 states with the higher limits during 1989. The data source used was the Fatal Accident Reporting System of the National Highway Traffic Safety Administration. It was found that the number of fatalities on rural interstate highways increased by 32% in 1989 compared to 1982-86. In contrast, the number of fatalities on all other roads only increased by 2% during this same period. Similarly, the number of fatalities on urban interstate highways increased by 8%. The estimated risk for a rural interstate fatality increased by 29% in 1989 relative to all other roads and increased by 22% relative to only urban interstates. Fatalities for drivers and occupants of passenger vehicles were examined separately. The relative risk of fatalities on rural interstates was also significantly higher for drivers and occupants of passenger vehicles in 1989. Among the eight states that maintained a 55 mph speed limit, the number of rural interstate fatalities in 1989 was 10% lower than the average for 1982-86. Over the same period the number of fatalities on all other roads increased by 3% and on urban interstates they increased 15%. The estimated risk of a rural interstate fatality declined 22% relative to urban interstates and 12% relative to all other roads. These results indicate that the 65 mph speed limits resulted in an increased risk of a fatality on rural interstates in the 40 states with higher speed limits. For all fatalities, the increased risk associated with the higher speed limit is 22-29%.

494241 DA

MOTOR VEHICLE CRASH FATALITIES IN THE SECOND YEAR OF 65 MPH SPEED LIMITS

Baum, HM; Wells, JK; Lund, AK

Pergamon Press, Incorporated

Journal of Safety Research VOL. 21 NO. 1 1990 pp 1-8

SUBFILE: HRIS

AVAILABLE FROM: Pergamon Press, Incorporated Maxwell House, Fairview Park Elmsford New York 10523

In 1987, the federal government relaxed the 55 mph (88 km/h) national maximum speed limit, permitting states to post 65 mph (104 km/h) speed limits on rural interstate highways. By the end of 1987, 38 states had done so; and two additional states followed suit in 1988. It is estimated that the higher speed limit caused motor vehicle crash fatalities to be 26% higher in 1988 than they would have been if the speed limit had remained at 55 mph. This translates into over 500 deaths attributable to the higher speed limits on rural interstate highways. Overall, it is estimated that more than 700 people, who would have lived had the limit not been raised, have died on rural interstate highways since states began to post 65 mph limits in 1987. The effect of the higher limit doubled between 1987 and 1988, and the 65 mph limit may cost far more in death and injury than predicted prior to the speed limit increase.

612525 DA

OPPORTUNITIES FOR FRONTAL CRASH PROTECTION AT SPEEDS GREATER THAN 35 MPH. FRONTAL CRASH SAFETY TECHNOLOGIES FOR THE 90'S

Digges, KH; Morris, JB

Society of Automotive Engineers 400 Commonwealth Drive Warrendale Pennsylvania 15096 1-56091-116-6

Feb 1991 11p Figs. Refs.

REPORT NO: SP-852

SUBFILE: HRIS

AVAILABLE FROM: Society of Automotive Engineers 400 Commonwealth Drive Warrendale Pennsylvania 15096

This paper summarizes some of the relevant research which was sponsored by the National Highway Traffic Safety Administration (NHTSA) under the direction of the authors. Results particularly applicable to current vehicle configurations are highlighted. Oppor tunities for further improvement, and required research are discussed. The IVHS (Intelligent Vehicle-Highway System) program now underway at the Department of Transportation offers a mechanism for achieving significant improvements in occupant protection.

373364 DA
OPTIMAL SPEED LIMIT: A NEW APPROACH (ABRIDGMENT)
McLeod, DS (Environmental Science and Engineering, Inc)
Transportation Research Board
Transportation Research Record N887 1982 pp 1-2 5 Ref.
SUBFILE HRIS
AVAILABLE FROM: Transportation Research Board Publications Office 2101 Constitution Avenue, NW Washington D.C 20418
The private optimal speed for a driver and the optimal speed limit imposed by a government are two different things. An individual can determine his or her optimal driving speed by comparing the costs of increased speed (greater gasoline consumption and greater probability of an accident) with the benefits (reduced travel time). A driver's private optimum speed does not, however, take into account any damage that his or her extra speed may do to others This is an external cost of speed, which provides a rationale for government regulation of highway speed. In this paper we present a method for calculating the optimal speed limit It starts with the privately chosen speed and then adjusts it to account for external costs. One advantage of this method is that it is based on the driver's judgment about the value of his or her life rather than on an externally imposed estimate. After deriving a formula for the optimal speed limit, we use it in a simple numerical example that provides (a) an estimate of the optimal speed limit; (b) an estimate of the cost per life saved of a suboptimal speed limit, which can be compared with the costs of other ways of saving lives; and (c) an understanding of the types of information needed to improve estimates of the optimum. (Author) This paper appeared in Transportation Research Board Record No. 887, Economic Analysis Issues

396387 DA
PAGAN'S PERSPECTIVE
Better Roads VOL. 55 NO. 5 May 1985 pp42
SUBFILE: HRIS
AVAILABLE FROM: Better Roads P.O. Box 558 Park Ridge Illinois 60068
The author contends that the need for a national 55 mph speed limit is not as compelling as it was when the limit was enacted. When inflation and the improved gas mileage of present-day automobiles are taken into account the cost of gasoline per mile is about the same as in 1970. Furthermore, only about one third of the total vehicle mileage traveled in the U.S. access on roads where speeds of 55 mph or more are possible, and only half of those vehicle miles are actually negotiated at or above 55. Assuming a 12 percent average fuel savings when not speeding, the total savings is less than 2 percent. Since the petroleum used in highway transportation accounts for only a quarter of the nation's energy consumption, the savings from the speed limit represent only one half of one percent of U S. energy needs. Regarding safety, the authors notes that most large interstate highways have been designed for speeds greater than 65 mph He notes that when speed limits are set using the 85th percentile speed on a given highway, accidents will be reduced, regardless of whether the new limit is above or below the old. In the author's opinion, time currently spent enforcing the speed limit could be better utilized keeping impaired drivers off the road and enforcing seat belt laws.

475209 DA
PAGAN'S PERSPECTIVE. HIGHWAYS IN GREAT BRITAIN: PART 1 - THE MOTORWAYS SYSTEM
Pagan, AR
Better Roads VOL. 57 NO. 11 Nov 1987 pp 38-40
SUBFILE: HRIS
AVAILABLE FROM Better Roads P.O. Box 558 Park Ridge Illinois 60068
These comments on the British motorways draws from information contained in "A History of British Motorways" by George Charlesworth, published by Thomas Telford Limited of London. The definition of the term Motorways is given, and it is noted that the motorway tends to parallel the design and development of the U S. interstate highway system. Economics dictated some changes in the design standards as construction proceeded in the 1960s. For example, the 1966 standard cross-section for a dual 3-lane road which was 129-ft overall, was reduced to 116 feet. The 1970 election of the conservative government and the 1973 oil crisis led to a de-emphasis of motorway construction. The oil crisis also led to an experimental speed limit of 50 mph. During this 6-month period, there was a reduction in accidents of 40% in daylight and 28% in darkness over and above that likely to be explained by trends with time and seasonal variation and also with reduction in traffic 1979 data indicate that in a little over 1,500 miles of motorway, 4,044 accidents resulted in 201 fatalities. A study concluded that a 1% rise in the average speed resulted in a 2.85% increase in all accidents

603699 DA
PRELIMINARY ASSESSMENT OF THE INCREASED SPEED LIMIT ON RURAL INTERSTATE HIGHWAYS IN ILLINOIS (ABRIDGMENT)
Sidhu, CS
Transportation Research Board
Transportation Research Record N1281 1990 pp 78-83 3 Fig. 4 Tab. 1 Ref.
SUBFILE: HRIS
AVAILABLE FROM· Transportation Research Board Publications Office 2101 Constitution Avenue, NW Washington D.C. 20418
In May 1987, a 65-mph speed limit was posted on rural Interstate highways in Illinois. The effect of the change in vehicle speeds on the incidence of accidents is assessed for the first year. The method consisted of using 5 years of data collected before the new speed limit and subjecting these data to linear regression to project the number of accidents had there been no change in the posted speed limit The projected number of accidents of each type was then compared with the reported numbers for the period of the assessment. Average speeds of passenger vehicles on the rural Interstates increased from 59.8 mph during the preceding year to 61.8 mph during the initial 12 months of the increased speed limit. The number of fatal accidents (expected versus reported) increased on each of the three different types of highways (15.2% on rural Interstates, 20 3% on urban Interstates, and 2.9% on the primary system of highways). Most of the increase in fatal accidents on the rural Interstates may be attributed to the increase in fatal pedestrian accidents and fatal accidents involving drinking and driving. Results indicate that the higher posted

speed limit in Illinois did not have a clearly noticeable or an obviously adverse effect on fatal accidents during its first year. This paper appears in Transportation Research Record No. 1281, Human Factors and Safety Research Related to Highway Design and Operation.

379408 DA

PRESENTING SAFETY INFORMATION TO TRAFFIC VIOLATORS

McKnight, AJ; Katz, DB

National Public Services Research Institute 123 North Pitt Street Alexandria Virginia 22314; National Highway Traffic Safety Administration 400 7th Street, SW Washington D.C. 20590

Aug 1982 Final Rpt. 64p 8 Tab. Refs. 2 App.

REPORT NO: HS-806 386

CONTRACT NO: DOT-HS-8-02062; Contract

SUBFILE: HRIS; HSL

AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161

This report describes the evaluation of a system for disseminating safety information to traffic violators through warnings issued by law enforcement officers. The objective of this approach was to reach traffic violators who are not cited for traffic offenses and, therefore, do not receive the type of safety information given to convicted traffic violators through court-sponsored traffic schools and State driver improvement systems. Through a series of pilot tests conducted in Iowa and Maryland, an informational booklet dealing with the dangers, financial penalties, legal consequences of speeding violation was developed. Informational material was accompanied by a brief open book test that was mailed back to the police. The materials were evaluated for their effect upon accidents and violations in the State of Maryland. The informational materials and tests were bound into warning booklets such that every other driver received the materials. The total sample included 36,906 drivers. Two-thirds of the drivers receiving informational materials returned tests. Records of accidents and violations following issuance of warnings revealed no differences between the groups receiving the warnings with and without informational materials. While the followup period was not of sufficient length to warrant a final conclusion, and additional analysis was recommended, the authors believe that available data justify a tentative conclusion that the informational system was not effective in increasing compliance with the 55 mph limit or reducing speed-related accidents.

425936 DA

RAISING THE OPEN ROAD SPEED LIMIT: THE EFFECT ON ACCIDENT RATES

Jones, WR; Derby, NM; Frith, WJ

New Zealand Roading Symposium New Zealand Roading Vol. 3 1987 pp 597-606

SUBFILE: UCITS; TLIB

No abstract available.

607315 DA

RECONSTRUCTION OF MOTOR VEHCLE ACCIDENTS: A TECHNICAL COMPENDIUM. FRONTAL CRUSH ENERGY AND IMPULSE ANALYSIS OF NARROW OBJECT IMPACTS

Smith, GC; James, MB; Perl, TR; Struble, DE

Society of Automotive Engineers 400 Commonwealth Drive Warrendale Pennsylvania 15096 0-89883-122-9

1989 pp 405-415 Figs. Tabs. Refs. 1 App.

REPORT NO: PT-34

SUBFILE: HRIS

AVAILABLE FROM: Society of Automotive Engineers 400 Commonwealth Drive Warrendale Pennsylvania 15096

This paper examines methods of estimating the energy dissipated by the frontal crush of automobiles which impact narrow objects such as poles or trees. The method originally developed by Campbell for full frontal crashes is found to underestimate the energy for narrow object impacts by as much as 68 percent in those cases investigated. A correction factor equivalent to that used by NASS to account for induced bowing is found to improve the estimation in all cases investigated, improving the error to 37 percent in the worst case. An exploratory study using a previously reported technique of approximating a single high speed crash with a series of repeated low speed crashes is presented with promising results. The unique nature of narrow object impacts in impuulse analysis is also discussed. It is shown that the principal direction of force is not necessarily the same as the direction of crush of the car outer surface.

607272 DA

RECONSTRUCTION OF MOTOR VEHICLE ACCIDENTS: A TECHNICAL COMPENDIUM. ANALYTICAL APPROACH TO AUTOMOBILE COLLISIONS

Emori, RI

Society of Automotive Engineers 400 Commonwealth Drive Warrendale Pennsylvania 15096 0-89883-122-9

1989 pp 75-83 Figs. Refs.

REPORT NO: PT-34

SUBFILE: HRIS

AVAILABLE FROM: Society of Automotive Engineers 400 Commonwealth Drive Warrendale Pennsylvania 15096

Analyses of some of available experimental results suggest that frontal and rear-end automobile collision processes may be simulated by a simple model with a mass, which represents the vehicle mass, and a spring, which represents the resisting force due to crushing of the vehicle structure. Indication are that in the case of barrier and head-on collisions, the spring is one-way linear, and the rate does not vary with colliding speeds provided that the type of vehicle and the mode of collisions remain the same. On the other hand, in the case of rear-end collisions, experiments indicate that the spring is almost rigid-plastic. The occupant's motion was also studied by a simulated model. A parametric study was made to obtain a design criterion for safety harnesses and vehicle interior geometry relative to occupants for injury reduction.

607298 DA

RECONSTRUCTION OF MOTOR VEHICLE ACCIDENTS: A TECHNICAL COMPENDIUM. A REVISED DAMAGE ANALYSIS PROCEDURE FOR THE CRASH COMPUTER PROGRAM

McHenry, RR; McHenry BG

Society of Automotive Engineers 400 Commonwealth Drive Warrendale Pennsylvania 15096 0-89883-122-9

1989 pp 259-270 Figs. Tabs. Refs. Apps.

REPORT NO: PT-34

SUBFILE: HRIS

AVAILABLE FROM: Society of Automotive Engineers 400 Commonwealth Drive Warrendale Pennsylvania 15096

A revised damage analysis procedure for CRASH, which includes restitution effects, is described. The proposed calculation procedure has the potential capability of (1) improving the delta-V accuracy in low-speed collisions and (2) segregating stiffness and restitution properties. The analytical approach can provide a basis for refinement of the categorization of vehicles through its use of additional crush property descriptors. Sample results from applications of a prototype computer routine are presented and compared with corresponding results from the original damage routine of CRASH.

562992 DA

REDUCING RUNAWAY TRUCK ACCIDENTS THROUGH WEIGHT-BASED ADVISORY SPEEDS

Firestine, M; McGee, HW; Cunningham, D

US Dept of Transportation Federal Highway Administration McLean VA

Sep 1989 Summary Report 18 pp

REPORT NO: FHWA-IP-89-023

CONTRACT NO: DTFH61-88-R-00072.

SUBFILE: UCITS; TLIB

No abstract available.

604234 DA

REDUCTION IN THE SPEED LIMIT FROM 110 KM/H TO 90 KM/H DURING SUMMER 1989: EFFECTS ON PERSONAL INJURY ACCIDENTS, INJURED AND SPEEDS

Nilsson, G

National Swedish Road & Traffic Research Institute Fack S-581 01 Linkoeping Sweden

1990 27p

REPORT NO: VTI-358A

SUBFILE: HRIS; NTIS

AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161

On behalf of the Road Safety Office the Institute has analyzed the effect of the reduced speed limit during summer 1989. The traffic safety situation on rural roads during summer 1989 improved in relation to the corresponding period in 1988. As expected, the improvement was greatest on those roads where the speed limit was reduced from 110 km/h to 90 km/h, particularly on motorways. See also PB90-259292.

602814 DA

REDUCTION OF THE 110 KM/H SPEED LIMIT TO 90 KM/H DURING SUMMER 1989. EFFECTS ON PERSONAL INJURY ACCIDENTS, INJURED AND SPEEDS

Nilsson, G

National Swedish Road & Traffic Research Institute Fack S-581 01 Linkoeping Sweden

1990 37p Swedish

REPORT NO: VTI-358

SUBFILE: HRIS; NTIS

AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161

The effect of the reduced speed limit during summer 1989 was analyzed. The reduction in the 110 km/h during summer 1989 on 5500 km of roads led to lower speeds than in 1988 not only on the road sections involved but also on other main roads. Summing up, the traffic safety situation on rural roads during summer 1989 improved in relation to the corresponding period in 1988. As expected, the improvement was greatest on those roads where the speed limit was reduced from 110 km/h to 90 km/h, particularly on motorways. The reduction in speed was also greatest on motorways.

603698 DA

RELATIONSHIP OF 65-MPH LIMIT TO SPEEDS AND FATAL ACCIDENTS

McKnight, AJ; Klein, TM

Transportation Research Board

Transportation Research Record N1281 1990 pp 71-77 2 Fig. 3 Ref.

SUBFILE: HRIS

AVAILABLE FROM: Transportation Research Board Publications Office 2101 Constitution Avenue, NW Washington D.C. 20418

A time series analysis was performed on fatal accidents, injury accidents, vehicle miles traveled, and vehicle speeds over the 5 years preceding and 1 year following the increase in the national maximu speed limit (NMSL) allowed during the spring of 1987 on rura Interstate highways. In the states that raised their limits to 65 mph, speeding on rural Interstates increased by 48% and fatal accidents increased by 27% over projections based on previous trends. A 9% increase in speeding and a 1% increase in fatalities were observed on highways still posted at 55 mph. In the states that retained the 55-mph limit, fatal accidents increased by slightly more than 10% both on rural Interstates and other posted highways coincident with the change in the NMSL. Speeding on the two classes of highways increased by 18% and 37%, respectively. The total increase in fatal accidents attributed to the raised speed limit, both in 65-mph and 55-mph states, was estimated at approximately 300/year. A shift of high-speed traffic to rural Interstates from other highways may have contributed to the changes occurring in the 65-mph states. The increase in fatal accidents on 55-mph non-Interstate highways in states that did not raise their limits may have been caused, in part, by the absence of such a shift. This paper appears in Transportation Research Record No. 1281, Human Factors and Safety Research Related to Highway Design and Operation.

445109 DA

REPORT TO CONGRESS ON THE EFFECTS OF THE 65 MPH SPEED LIMIT DURING 1987

National Highway Traffic Safety Administration Washington DC

Jan 1989

SUBFILE: UCITS; TLIB

No abstract available.

477843 DA

RURAL SPEED LIMIT AND TRAFFIC ACCIDENTS

Fieldwick, R; de Beer, E

National Institute for Transport & Rd Res, S Af P.O. Box 395 Pretoria 0001 Transvaal South Africa 0-7988-4078-1

Jan 1987 164p

REPORT NO: RV/26

SUBFILE: HRIS; NTIS

AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161

The investigation is a comprehensive examination of the relationship between rural speed limits and accidents. South Africa's road fatality rate is very high when compared to those of Western countries, and its urban and rural speed limits are above average. An analysis of twelve industrialized Western countries showed that their fatality rate could largely be explained in terms of their speed limits. Forty-eight speed limit changes in twelve countries are described, and three models relating the change in fatal, injury and total accidents with the change in mean speed have been developed. South Africa's accidents between 1972 and 1985 are analyzed against a number of factors by multiple linear regression. It is concluded that a change of speed on part of the road network affects accidents elsewhere on the network. It is recommended that the urban and rural speed limits be reduced to 50 and 90 km/h respectively.

i96594 DA

SAFETY AND OPERATIONAL IMPACTS OF RAISING THE SPEED LIMIT TO 65 MPH. FINAL REPORT

Upchurch, J; Rahman, M

Arizona State University, Tempe Center for Advanced Research in Transportation Tempe Arizona 85287; Arizona Department of Transportation 206 South 17th Avenue Phoenix Arizona 85007; Federal Highway Administration 400 7th Street, SW Washington D.C. 20590

Jan 1990 52p 22 Fig. 8 Tab. 1 Ref.

REPORT NO: FHWA-AZ90-288

CONTRACT NO: PL-1(33) Item 288; HP&R

SUBFILE: HRIS

AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161

Arizona's experience with the 65 mph speed limit is presented in terms of driver behavior and accident experience. The speed limit on Arizona's rural Interstate was raised to 65 mph on April 15, 1987. Driver behavior is presented in terms of the speeds which motorists actually drive on the rural Interstate. Before and after data are presented from the last quarter of 1983 through the first quarter of 1988. Vehicle speeds increased by only about 3 mph or less during the four quarters following the speed limit increase. A five year history of Interstate accident data -- 1983 through Spring 1988 -- is presented which provides a before and after comparison. Total accidents, fatal accidents, and injury accidents information is presented. Accident rate information is presented to account for the effect of increasing vehicle miles of travel. Accident data on the urban Interstate are presented for comparison purposes.

600223 PR

SAFETY EFFECTS OF THE 65 MPH LIMIT AND THE MANDATORY SEAT BELT LAW

INVESTIGATORS: 30334

SPONSORING ORG: Georgia Department of Transportation

PERFORMING ORG: Georgia Institute of Technology; Georgia Department of Transportation 2 Capitol Square Atlanta Georgia 30332

PROJECT START DATE: 8906

PROJECT TERMINATION DATE: 9010

SUBFILE: HRIS

This project will review and summarize the experience of other jurisdictions with mandatory seat belt laws; measure the effects of the 65 mph speed limit law on fatal accidents, fatalities, fatal accident rates, and fatality rates; and measure the effects of the 65 mph speed limit law on accident severity as measured by police report injury codes.

600331 DA

SAFETY IMPACT OF THE 65 MPH SPEED LIMIT: A TIME SERIES ANALYSIS

Pfefer, RC; Stenzel, WW

Northwestern University, Evanston Traffic Institute, 555 Clark Street, P.O. Box 1409 Evanston Illinois 60204

Dec 1989 132p

REPORT NO: HS-807 524

SUBFILE: HRIS; NTIS

AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161

The project examines the effects of the national maximum speed limit change on vehicular speeds and safety on 1200 miles of rural interstate highways in the state of Illinois, where the increase from 55 to 65 mph occurred in May of 1987. The speed limit increase does not apply to trucks. Analyses were made of speed data from four individual speed monitoring sites, and the aggregate of 15 sites, on rural interstate roads. The results indicate that there was an increase in the 85th percentile speed of passenger vehicles, on the order of four, or five, miles per hour, correlated with the change in the law The frequency of all accidents increased on the order of 14 percent, in correlation with the law change. However, the same evidence could not be found for increases in either the frequency of serious accidents, or the accident rate. Furthermore, there was no strong evidence that speed differentials between cars and trucks were affected, or the car-truck accident experience changed.

602472 PR

SAFETY IMPACTS OF DIFFERENT SPEED LIMITS FOR CARS AND TRUCKS

INVESTIGATORS: Harkey, D

SPONSORING ORG: 30

PERFORMING ORG: Scientex Corporation 400 15th Street, S W Washington D.C. 20006

PROJECT START DATE: ND

PROJECT TERMINATION DATE: ND

SUBFILE: HRIS

The implications of lower speed limits for trucks on freeways will be examined in terms of highway safety, traffic and truck operations, enforcement, and economic impact. Truck speed and crash data in states with and without dual limits will be examined to assess the nature of multi-vehicle crashes on freeways, and whether the crashes that could be averted or increased as a result of separate truck limits represent a significant safety problem. Based on the finding, speed limits for trucks would be removed or lowered, as the case may be, on some freeway sections and evaluated before and after the change Some sections would

611999 DA

SAFETY IMPACTS OF THE 65-MPH SPEED LIMIT ON INTERSTATE HIGHWAYS

Chang, G-L; Carter, EC; Chen, C-H

Maryland University, College Park Department of Civil Engineering

College Park Maryland 20742, AAA Foundation for Traffic Safety 1730 M Street, Suite 401 Washington D C. 20036
Aug 1991 80p Figs. Tabs. 20 Ref.
SUBFILE: HRIS
AVAILABLE FROM: AAA Foundation for Traffic Safety 1730 M Street, Suite 401 Washington D C. 20036
This report studies the impact of the 65-mph speed limit on Interstate highway fatalities using the Box-Jenkins model and Box-Tiao intervention analysis. An extensive survey was conducted to collect accident information individually from each state, including the accident frequency during the 2-yr before (1985-1986) and the 2-yr after (1988-1989) periods. With several follow-up phone calls, the final survey results yield an accident data set for twelve 65-mph and two 55-mph states. This report summarizes the research results in the following sequence: Comparison of the accident frequency before and after the speed limit change in both 65-mph and 55-mph states; Assessment of the accident rate before and after the speed limit change in both 65-mph and 55-mph states; Evaluation of the long-term nationwide fatality pattern on rural Interstate highways, and Estimation of the 65-mph speed limit impact with intervention analysis. The report is organized as follows: Chapter 1 is an introduction. Chapter 2 describes the characteristics of data sets used for accident and fatality analyses. Preliminary results based only on the numerical change in fatalities and accidents between the before and after periods are also presented in this chapter. Chapter 3 first introduces three statistical tests for use in assessing the speed limit impacts on accidents, followed by a detailed discussion of the test results. Concluding comments with respect to the data quality and reliability of the research findings are also included. Chapter 4 investigates the speed limit impact on Interstate highway fatalities. A time-series model based on the Box-Jenkins method is presented along with some statistics for identificaion of any systematic trend in the fatality patterns. The standard intervention analysis is then applied in conjunction with the time-series model to test the statistical significance of the 65-mph speed limit on fatalities. The overall research findings and future research needs are summarized in Chapter 5.

615858 DA
SHORT TERM SAFETY EFFECTS OF THE 100 AND 120 KM/H SPEED LIMITS ON STATE HIGHWAYS
Roszbach, R; Blokpoel, A
Institute for Road Safety Research SWOV P.O. Box 170 2260 AD Leidschendam Netherlands
1989 67p Dutch
REPORT NO: R-89-48
SUBFILE: HRIS; NTIS
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161
From May 1, 1988 the speed limit on Dutch motorways was increased from 100 to 120 km/h. For a limited part of the motorway network the limit is still fixed at 100 km/h. The introduction of the modification in speed limit was attended by information, publicity and an increased police control. In the report the effect of these measures on traffic safety in the period up to the end of 1988 is evaluated. Accident data are correlated with recorded speed changes in the before and after period. It is concluded that: the composition of measures, despite the increase of speed limit, has produced a decrease in the actual driving speeds; the decrease in speed has lead to a notable increase in traffic safety; the safety aspects are not only limited to motorways, but also to other highway types; and within the limited after period of eight months a decrease of the effects and even in a given case a return to the old situation, is shown. Problems concerning the quantification of the effect, prognosis of effects with present policy and level of police surveillance, police control, and police enforcement are discussed. Available only in the U.S., Canada and Mexico. All others refer to National Institute for Road Safety Research SWOV, P.O. Box 170, 2260 AD Leidschendam, The Netherlands.

497050 DA
SIXTY-FIVE MPH SPEED LIMIT IN MICHIGAN: EFFECTS ON INJURY AND DEATH
Wagenaar, AC; Streff, FM, Schultz, RH
University of Michigan Transp Research Institute 2901 Baxter Road Ann Arbor Michigan 48109-2150
Dec 1989 74p
SUBFILE: HRIS, NTIS
AVAILABLE FROM. National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161
Effective December 1987 and January 1988, the maximum speed limit on rural limited-access highways in Michigan was raised from 55 mph to 65 mph. The study examined the effects of the raised limit on traffic crashes, injuries, and deaths. A multiple time-series was used, comparing roads where the speed limit was raised with roads where the limit remained unchanged. Data were collected on the numbers and rates of crashes, injuries and deaths from January 1978 through December 1988. Time series intervention analyses were conducted to estimate effects associated with the speed limit change while controlling for long-term trends, cycles, and other patterns. Statistical controls were also included for major factors known to influence crash and injury rates in the state. Results revealed significant increases in casualties on roads where the speed limit was raised. In addition, property-damage-only crashes increased 38.4% on 55 mph limited-access freeways, suggesting that the 65 mph limit may have spillover effects on segments of freeways where the limit was not changed. The increased convenience of reduced travel time with the higher speed limit is obtained at a significant cost in terms of crash injuries and death. See also PB89-135107

495841 DA
SPEED ANALYSIS OF PASSENGER CARS IN FREE-FALL LAUNCH MOTIONS
Le Fevre, WF
American Society for Testing and Materials
Journal of Forensic Sciences VOL. 31 NO. 3 Jul 1986 pp 886-902
Figs Tabs. 1 Ref.
REPORT NO: HS-039 889
SUBFILE: HSL
AVAILABLE FROM: American Society for Testing and Materials 1916 Race Street Philadelphia Pennsylvania 19103
Appliled forensic engineering in the field of accident reconstruction is often required to determine vehicle speeds in crash and collision cases. One type of automobile crash is that in which a car becomes airborne after being launched from an abrupt change of ground contour. This treatise covers an analysis of speed at launch surface. A refinement is

introduced accounting for the effect of pitch motion of the vehicle to obtain a more accurate evaluation of speed.

488771 DA

SPEED AND TRAINING FACTORS ASSOCIATED WITH HEAVY TRUCK ACCIDENTS

Beilock, R; Capelle, RB, Jr; Page, EB

Eno Foundation for Transportation, Incorporated

Transportation Quarterly VOL. 43 NO. 4 Oct 1989 pp 571-589 1 Fig. 4 Tab.

SUBFILE: HRIS

AVAILABLE FROM: Eno Foundation for Transportation, Incorporated P.O. Box 2055, Saugatuck Station Westport Connecticut 06880-0055

In response to increased public focus on the safety of commercial transportation, the Office of Technology Assessment (OTA) has recently completed a Congressionally-requested study identifying factors contributing to heavy vehicle accidents. OTA found two factors most commonly associated with heavy vehicle accidents: speed too fast for conditions and the level of driver training. This paper draws from analyses of existing data sources conducted by OTA and from the Regular Common Carrier Conference's 1987 Motor Carrier Safety Survey to identify and promote safe operating speeds and driver training. Conclusions are drawn from the results of a multivariate model explaining accident probabilities. A systmatic approach is introduced for identifying accident-prone driver types and isolating effects of individual contributing factors.

370607 DA

SPEED LIMITS FOR OVERWIDTH VEHICLES ON VIRGINIA HIGHWAYS

Pastel, CR; Lynn, CW

Virginia Highway & Transportation Research Council P.O. Box 3817, University Station Charlottesville Virginia 22903; Virginia Department of Highways and Transportation 300 Turner Road Richmond Virginia 23225

Sep 1980 Tech Memo n.p.

REPORT NO: VHTRC-81-R17

SUBFILE: HRIS

This study examined the data collected during the Research Council's 1976 study of the transportation of 12- and 14-foot wide manufactured housing units to determine whether the data were adequate for analyzing the effects of wide load speed on other traffic and, if possible, to determine what these effects were. The major conclusion from the examination of the data was that the wide load vehicles traveling above 45 mph on interstate and four-lane divided highways had lower accident potentials than did those traveling at slower speeds. Accordingly, it was recommended that the speed limit on interstate and four-lane divided highways for overwidth manufactured housing units be changed to 55 mph, the speed which would put these vehicles in reasonable conformity with other traffic.

473168 DA

SPEED ZONING AND CONTROL. FINAL REPORT

Dudek, CL; Ullman, GL

Texas Transportation Institute Texas A&M University College Station Texas 77843; Texas State Department of Highways & Public Transp Transportation Planning Division, P.O Box 5051 Austin Texas 78763; Federal Highway Administration 400 7th Street, SW Washington D.C. 20590

Aug 1987 77p Figs. Tabs. 20 Ref. 3 App.

REPORT NO: FHWA/TX-87/334-2F; Res Rept 334-2F

CONTRACT NO. Study 2-18-84-334; Contract

SUBFILE: HRIS

AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161

Field studies have been conducted at a limited number of Texas sites to investigate and evaluate speed zoning procedures 1) at speed zones in rapidly developing urban fringe areas, 2) at transition section speed zones on highway approaches to cities or towns, and 3) at speed zones recently lowered below the 85th percentile speed in response to local community pressure. Posting speed limits below the 85th percentile speed in rapidly developing areas had no conclusive effect on speeds or accidents. Studies at transition section speed zones showed that fewer speed limit signs could be used to adjust between rural and urban speed limits withouot adversely affecting traffic speeds. Studies at speed zones recently lowered after considerable community pressure showed that overall speeds were also not lowered by reduced speed limits. The results come from a limited number of studies, and should not be taken as totally conclusive. The studies do not support a departure from the 85th percentile speed criteria currently used in Texas speed zoning procedures. It is recommended, however, that the procedures emphasize that fewer speed limit signs may be used in transition sections.

479290 DA

SPEEDS, SPEED LIMITS, AND ACCIDENTS. THE ROAD SAFETY TREND IN BUILT UP AREAS AFTER THE INTRODUCTION OF THE 50 KM/H LIMIT. DOCUMENTATION

Engel, U; Thomsen, LK

Danish Council of Road Safety Research Ermelundsvej 101 DK-2820 Gentofte Denmark 0106-6609

Oct 1988 69p 25 Fig. 13 Tab. Refs.

REPORT NO: Tech Rept 3/1988

SUBFILE: HRIS

AVAILABLE FROM: Danish Council of Road Safety Research Ermelundsvej 101 DK-2820 Gentofte Denmark

This technical report describes the road safety effect of the lowering of the general speed limit in built up areas from 60 km/h to 50 km/h. It reveals that the injury accidents dropped 9% while the number of fatalities was reduced 24% after the introduction of the 50 km/h speed limit in built up areas. In general, it indicates that speed limits in the period from 1974 to 1987 have reduced the fatality rate 38% Another finding is that the accident rate in rural areas shows a decreasing trend from 1979 to 1987.

444421 DA

STATISTICAL ANALYSIS OF OPERATING SPEEDS AND ACCIDENT RATES ON TWO-LANE RURAL HIGHWAYS

Choueiri, EM

Thesis Ph.D. Clarkson University, 1986

SUBFILE: UCITS; TLIB

AVAILABLE FROM: University Microfilms International Ann Arbor, Mich

No abstract available.

469230 DA

SYNTHESIS OF SPEED ZONING PRACTICES. TECHNICAL REPORT

Parker, MR, Jr

Parker (Martin R) & Associates, Incorporated 44236 Suffolk Court Canton Michigan 48187; Federal Highway Administration 400 7th Street, SW Washington D.C. 20590

Jul 1985 58p

REPORT NO: FHWA/RD-85/096; FCP 31A4-034

CONTRACT NO: DTFH61-83-C-00128; Contract

SUBFILE: HRIS

AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161

This research was conducted to examine State and local speed laws, regulations, and current practices for setting speed limits. The information for the study was obtained from a review of the literature and a mail survey of State and local highway officials conducted by a Task Force of the AASHTO Subcommittee on Traffic Engineering. Throughout years of experimentation and observation, little consensus has been reached concerning criteria that should be used to establish speed limits. While the 85th percentile speed is considered as a major factor in all States and most localities, the deviations from the 85th percentile that are used to establish the speed limit can result in an arbitrary limit. The diversities in State and local laws, the lack of national guidelines, and the variety of methods currently in use suggest that non-uniform speed zones are commonplace. There is an immediate need to validate the applicability of existing methods and/or to develop new objective criteria that will lead to establishing realistic speed zones. There is also a need to examine the potential benefits of establishing minimum speed limits. Objective methods for setting speed limits in work zones should be explored. State and local officials also identified the need to determine the effects of raising or lowering speed limits on speed and accidents

390528 DA

THE 55-MPH SPEED LIMIT: A REVIEW

American Society of Civil Engineers

Journal of Transportation Engineering VOL. 106 NO. TE3 May 1980 pp 299-308 15 Ref.

REPORT NO: HS-029 909

SUBFILE: HSL

AVAILABLE FROM: American Society of Civil Engineers 345 East 47th Street New York New York 10017

The current status of knowledge regarding the fifty-five mile per hour speed limit is summarized, indicating the complexity of evaluating the safety impact of the reduced speed limit. The following factors are considered: motor vehicle travel, speed limit reduction differences, driver behavior, enforcement, accident reporting systems, data base deficiencies, roadway improvements, roadway condition and maintenance, and motor vehicle design changes. Conclusions/recommendations are cited from 55 mph evaluation studies by the Institute of Transportation Engineers, American Association of State Highway and Transportation Officials, University of Washington, Pennsylvania Transportation Institute, and Department of Transportation. These studies and available information indicate that there has been a change in traffic behavior and accident experience since the late 1973 and early 1974 period (the 55 mph law enacted in January 1974) but that there is disagreement related to cause and effect. It is recommended that national attention be focused on the current costs and benefits of the 55 mph speed limit to provide full documentation for either support or rejection of this controversial speed control measure. Prepared by Committee on Traffic and Highway Safety of the American Society of Civil Engineers.

377412 DA

THE 55 MPH SPEED LIMIT: COSTS, BENEFITS, AND IMPLIED TRADE-OFFS

Kamerud, DB (General Motors Research Laboratories)

Pergamon Press Limited

Transportation Research. Part A: General VOL. 17A NO 1 Jan 1983 pp 51-64 3 Fig. Tabs. Refs. 3 App.

REPORT NO: HS-034 568

SUBFILE: HRIS; HSL

AVAILABLE FROM: Pergamon Press Limited Headington Hill Hall Oxford OX3 0BW England

This paper examines the societal effects of the 55 mph speed limit Fuel, accident, trucking productivity and travel time effects are estimated for each of several rural road systems, and are then converted to units of money, lives and time. A graphical method is developed which permits the reader to compare trade-offs of money, lives, and time to one another and to decide whether his own values of life and time favor a given trade-off. When applied to the speed limit effects estimated here, this method suggests that the limit is less favorable on the rural interstate system than on other affected systems. Indeed, critics using certain plausible values of life and time could argue that the 55 mph limit is actually unfavorable to the users of the rural interstates.

601533 DA

THE 65-MPH SPEED LIMIT IN MICHIGAN: A SECOND YEAR ANALYSIS OF EFFECTS ON CRASHES AND CRASH CASUALTIES. FINAL REPORT

Streff, FM; Schultz, RH

University of Michigan Transp Research Institute 2901 Baxter Road Ann Arbor Michigan 48109-2150

Sep 1990 55p 14 Fig. 4 Tab. Refs. 4 App.

REPORT NO: UMTRI-90-37

CONTRACT NO: MPT-90-003A; Contract

SUBFILE: HRIS

AVAILABLE FROM: University of Michigan Transp Research Institute 2901 Baxter Road Ann Arbor Michigan 48109-2150

Effective December 1987 and January 1988, the maximum speed limit on rural limited-access highways in Michigan was raised from 55 mph to 65 mph. This study examined the effects of the raised limit on traffic crashes and crash casualties. A multiple time-series design was used, comparing roads where the speed limit was raised with roads where the limit remained unchanged. Data were collected on the numbers and rates of crashes, injuries, and deaths from January 1978 through December 1989. Time-series intervention analyses were conducted to estimate effects associated with the speed limit change while controlling for long-term trends, cycles, and other patterns. Statistical controls were also included for major factors known to influence crash and injury rates in the state Results revealed significant increases in casualties on roads where the speed limit was raised: 28.4% increase in fatalities; 38.8% increase in serious (A-level) injuries; and 24.0% increase in moderate (B-level) injuries These increases in crash casualties on 65-mph roads have resulted in 31 additional deaths, 420 serious injuries, and 491 moderate injuries over the 25-month period studied. The societal cost of these casualties is nearly $98 million. No changes in crash casualty figures were found for 55-mph limited-access highways or other roads. There was also no change in the number of traffic units involved in crashes on 65-mph roads suggesting the major influence of the higher speed limit is increased injury severity for crash involved persons.

601789 DA

THE 65 MPH SPEED LIMIT IN MICHIGAN: EFFECTS ON INJURY AND DEATH

Wagenaar, AC; Streff, AC; Schultz, RH

University of Michigan Transp Research Institute 2901 Baxter Road Ann Arbor Michigan 48109-2150

Dec 1989 76p

REPORT NO: UMTRI-89-28

SUBFILE: HRIS

AVAILABLE FROM: Transportation Research Board 2101 Constitution Avenue, NW Washington D.C. 20418

Effective December 1987 and January 1988, the maximum speed limit on rural limited-access highways in Michigan was raised from 55 mph to 65 mph. This study examined the effects of the raised limit to traffic crashes, injuries, and deaths. A multiple time-series design was used, comparing roads where the speed limit was raised with roads where the limit remained unchanged. Data were collected on the numbers and rates of crashes, injuries, and deaths from January through December 1988. Times series intervention analyses were conducted to estimate effects associated with the speed limit change while controlling for long-term trends, cycles, and other patterns. Statistical controls were also included for major factors known to influence crash and injury rates in the state. The results revealed significant increases in casualties on roads where the speed limit was raised. In addition, property-damage-only crashes incresed substantially.

611950 DA

THE CONTRIBUTION OF ROLLOVER TO SINGLE-VEHICLE CRASH INJURIES

Terhune, KW

Calspan Advanced Technology Center P.O. Box 400 Buffalo New York 14225; AAA Foundation for Traffic Safety 1730 M Street, Suite 401 Washington D.C. 20036

Mar 1991 59p Figs. Tabs. Refs.

REPORT NO: Calspan RN 7881-1

SUBFILE: HRIS

AVAILABLE FROM: AAA Foundation for Traffic Safety 1730 M Street, Suite 401 Washington D.C. 20036

The objective of this study was to clarify whether and how rollover raises the risks of occupant injury in crashes. Previous research showed that injury rates were at least twice as great in rollover crashes as in non-rollover ones, but the higher injury rates in rollovers could have been the result of higher crash speeds required to cause overturn. Consequently, methods were adopted in this study to account for crash speeds in comparing injury rates in rollover and non-rollover single-vehicle crashes. Comparisons included the effects on belted and non-belted drivers, and special analyses addressed the question of whether ejection was the main injury mechanism in overturn crashes. The data examined were automated databases from the accident files of North Carolina and the National Accident Sampling System (NASS). It was concluded that: (1) Beyond the effects of impact speed, vehicle overturning increases driver serious injury rates by 10% to 50%; (2) The driver serious injury rates of vehicle models tend to increase moderately with their rollover rates, but the relationship may be partially due to vehicle size and the effects of driver age; (3) Ejection is a major source of rollover injuries, and restraint systems greatly benefit drivers in both overturn and non--overturn crashes; (4) Rollover serious injuries are primarily to the head, abdomen/pelvis, and chest.

426156 DA

THE EFFECT OF INEXPENSIVE ACCIDENT COUNTER-MEASURES ON VEHICLE SPEED AND LATERAL PLACEMENT AT NARROW BRIDGES

Bowman, BL; Brinkman, P

National Research Council Transportation Research Board Washington DC

Paper presented at the 1988 Annual Meeting of the Transportation Research Board, Washington, DC Paper No. 870183

1988 37 pp

SUBFILE: UCITS; TLIB

No abstract available.

318507 DA

THE EFFECT OF THE 55 MPH SPEED LIMIT ON TRAFFIC ACCIDENTS IN ILLINOIS

Klein, TM

National Highway Traffic Safety Administration 400 7th Street, SW Washington D.C. 20590

Apr 1980 Tech Rpt. 16p

REPORT NO: DOT-HS-805-400; HS-805 400

SUBFILE: NTIS; HRIS; TSRF; TSC

AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161

The original intention of the 55 mph speed limit law following the Middle East Oil Embargo was to reduce gasoline consumption. A substantial reduction in traffic accidents, particularly fatal accidents, was experienced as a result of both the fuel shortage and the lowered speed limit. The State of Illinois experienced statistically significant reductions in fatal and injury accidents on Federal Aid Interstate and other State marked routes during the 55 mph speed limit time period. In addition, there were reductions in accidents on all road types, regardless of posted speed limit, during the period of the fuel shortage (October 1973-March 1974).

554817 DA

THE EFFECT OF THE 65 MPH LIMIT ON SPEEDS AND ACCIDENTS

McKnight, AJ; Klein, TM; Tippetts, AS

US Dept of Transportation National Highway Traffic Safety Administration Washington DC

May 1987 Final Report 44 pp

REPORT NO: DOT HS 807 463

CONTRACT NO: DTNH22-88-Z-47192.

SUBFILE: UCITS; TLIB

Available through the National Technical Information Service

No abstract available.

491187 DA

THE EFFECT OF TRUCK TRAFFIC CONTROL STRATEGIES ON TRAFFIC FLOW AND SAFETY ON MULTILANE HIGHWAYS

Garber, NJ; Gadiraju, R

Virginia University Department of Civil Engineering Charlottesville Virginia 22904

Sep 1989 96p 20 Fig. 24 Tab. 10 Ref. 5 App

REPORT NO: UVA/537363/CE90/101

SUBFILE: HRIS

AVAILABLE FROM: AAA Foundation for Traffic Safety 1750 M Street, Suite 401 Washington D.C 20036

The increased operation of trucks (defined here as vehicles having six or more wheels in contact with the road and having a gross vehicle weight greater than 10,000 lbs) on interstate and primary highways, which has been encouraged by recent legislation, has been found to affect safety and the quality of traffic flow on multilane highways. The concept of imposing certain restrictions on truck operations on multilane highways has therefore been identified as a means of reducing this effect. However, the overall impact of these restrictions on safety and traffic flow has not been fully studied. For example, either restricting trucks to a specific lane (or lanes) or imposing a lower speed limit on them, could have varied impact on traffic. The primary objective of this research is to provide information about the nature and extent of the impacts of such truck control strategies on traffic flows, speeds, headways, and accident patterns Simulation technique was used to study the effects of implementing different strategies on multilane highways Impacts of the strategies were evaluated and compared, and the significant changes in flows, speeds, headways, and accidents are presented The results did not indicate any safety benefits from the imposition of any of these strategies but suggested that the potential for an increase in accident rate will be created, particularly when the strategies are imposed on highways with high volumes, a high percentage of which is trucks.

491964 DA

THE EFFECTS OF THE 65 MPH SPEED LIMIT THROUGH 1988. A REPORT TO CONGRESS

National Highway Traffic Safety Administration 400 7th Street, SW Washington D.C. 20590

Oct 1989 265p 7 Fig. 45 Tab. 1 App.

SUBFILE: HRIS

AVAILABLE FROM: National Highway Traffic Safety Administration 400 7th Street, SW Washington D.C. 20590

The Surface Transportation and Uniform Relocation Assistance Act of 1987, enacted on April 2, 1987, allows states to raise the speed limit up to 65 mph on Interstate roads passing through areas with fewer than 50,000 people Between April 6, 1987 and July 1, 1988, forty states raised the speed limit to 65 mph on most of their rural Interstate roads. At this time, 89% of the nation's rural Interstate system (28,838 of 32,280 total miles) are posted at 65 mph. In addition, 1,132 miles of the urban Interstate system are posted at 65 mph. Available data show that the number of rural Interstate fatalities and the rural Interstate fatality rate increased after the speed limit was raised to 65 mph. Statistical models were used to refine the estimates of these changes by including additional historical information about the relationships between fatalities and travel. It is estimated that rural Interstate fatalities increased 16% in 1987 compared to 1986 (for the full year, in states that raised the speed limit at some time in 1987); the increase was 10% after accounting for travel increases on these roads. It is estimated that these fatalities increased 31% in 1988 compared to 1986 (in states that raised the speed limit during 1987); the increase was 21% after accounting for travel increases. Thus, about one-third of the fatality increase is attributed to greater travel, and about two-thirds is attributed to other factors (primarily to greater speed). Speed surveys show that average speeds and the percent of traffic traveling at high speeds increased. 18 states provided travel speed data for their 65 mph rural Interstate roads, and statistical models were used to interpret these data. The models suggest that two important changes occurred on the rural Interstates. First, the percent of traffic traveling at very high speeds increased (from 6% in the fall of 1986 to 16% in the fall of 1988 for vehicles traveling faster than 70 mph). Second, the variation among the travel speeds of vehicles on the road increased. The standard deviation of vehicle travel speeds was 6.0 mph in 1986 and 6.7 mph in 1988 The effects of these two changes were to increase the likelihood and severity of traffic collisions.

562950 DA

THE EFFECTS OF THE NEW 65 MILE-PER-HOUR SPEED LIMIT ON RURAL HIGHWAY FATALITIES: A STATE-BY-STATE ANALYSIS

Garber, S. Graham, JD

Accident Analysis and Prevention Vol. 22 No. 2 Apr 1990 pp 137-149

SUBFILE: UCITS, TLIB

No abstract available

608853 PR

THE IMPACT OF THE 65 MPH SPEED LIMIT ON VIRGINIA'S RURAL INTERSTATE HIGHWAYS

INVESTIGATORS Jernigan, JD; Lynn, CW

SPONSORING ORG: Virginia Department of Motor Vehicles Transportation Safety Administration

PERFORMING ORG Virginia Transportation Research Council P.O. Box 3817, University Station Charlottesville Virginia 22903

PROJECT START DATE. 8709

PROJECT TERMINATION DATE: ND

SUBFILE: HRIS

In April 1987, Congress passed the Surface Transportation and Uniform Relocation Assistance Act (STURAA) which permitted states to raise their maximum speed limit on rural interstate highways to 65 mph. Since then, 40 states, including Virginia, have adopted a 65 mph maximum speed limit. Virginia's 65 mph speed limit became effective for passenger cars on July 1, 1988, and for commercial buses on July 1, 1989. The findings presented in these reports summarize 18 months of experience with the 65 mph speed limit in Virginia with regard to speeds, speed variation, and accidents. REPORTS ISSUED: An Investigation of Issues Related to Raising the Rural Interstate Speed Limit in Virginia, Virginia Transportation Research Council, March 1988, Status Report on the Effects of the 65 mph Speed Limit on Virginia's Rural Interstate Highway System, January 1989, Status Report on the Inpact of the 65 mph Speed Limit on Virginia's Rural Interstate Highway through 1989, July 1990

603097 DA

THE IMPACT OF THE 65 MPH SPEED LIMIT ON VIRGINIA'S RURAL INTERSTATE HIGHWAYS THROUGH 1989

Jernigan, JD; Lynn, CW

Virginia Transportation Research Council P.O. Box 3817, University Station Charlottesville Virginia 22903; Virginia Department of Transportation 1221 East Broad Street Richmond Virginia 23219; Virginia University Charlottesville Virginia 22903; Virginia Department of Motor Vehicles P.O. Box 27412 Richmond Virginia 23269

Jun 1990 59p 2 Fig. 10 Tab 4 Ref. 5 App.

REPORT NO: VTRC 90-R15; Project 9245-061-940

SUBFILE: HRIS

AVAILABLE FROM: Virginia Transportation Research Council P.O. Box 3817, University Station Charlottesville Virginia 22903

In April 1987, Congress passed the Surface Transportation and Uniform Relocation Assistance Act (STURAA), which permitted states to raise their maximum speed limit on rural interstate highways (rural interstates) to 65 mph. Since then, 40 states, including Virginia, have adopted a 65 mph maximum speed limit. Virginia's 65 mph speed limit became effective for passenger cars on July 1, 1988, and for commercial buses on July 1, 1989 The findings presented in this report summarize 18 months of experience with the 65 mph speed limit in Virginia.

491841 DA

THE RELATIONSHIP BETWEEN SPEED AND ACCIDENTS: A LITERATURE REVIEW

Cowley, JE

Cowley, JE, and Associates P.O. Box 736 Caboolture 4510 Melbourne Australia 0-7306-0127-7, Road Traffic Authority 854 Glenferrie Road Hawthorn Victoria 3122 Australia

Mar 1987 46p 7 Fig. 2 Tab. Refs.

REPORT NO: GR/87/2; HS-040 149

SUBFILE: HRIS; HSL

AVAILABLE FROM: Road Traffic Authority 854 Glenferrie Road Hawthorn Victoria 3122 Australia

The aim of this report is to provide a review of the available literature on speed and accidents and to outline suggestions for further research in this area. The review concentrates on the relationship between speed behaviour and accident injury causation rather than upon methods of speed control. European studies show that reductions in travel speeds or speed dispersion have led to reduced accidents. U.S studies support the conclusion about speed dispersion but not travel speeds. U.S. studies also indicate that high skewness in the speed distribution might be associated with high accident rates and that vehicle involvement rates in rural accidents when plotted against travel speed form a U-shaped curve with minimum accident rates occurring close to the mean travel speed. The estimation of pre-crash speeds is still a major problem for research in this area.

603388 DA

THE SAFETY IMPACT OF 65 MPH SPEED LIMIT: A CASE STUDY USING ALABAMA ACCIDENT RECORDS

Brown, DB; Maghsoodloo, S; McArdle, ME

Pergamon Press, Incorporated

Journal of Safety Research VOL. 21 NO. 4 1990 pp 125-139 Figs. Tabs. Refs.

SUBFILE: HRIS

AVAILABLE FROM: Pergamon Press, Incorporated Maxwell House, Fairview Park Elmsford New York 10523

In August 1987 a change in Alabama laws went into effect raising the speed limit on the rural interstates to 65 mph. Two accident data sets (one year before and on year after the law change) were compared to assess the impact of the 65 mph speed limit on severity and frequency of accidents. Although accident severity appeared to remain the same from before to after time periods, the frequecncy of accidents on the rural interstates increasd significantly by 18.88%. However, the signifícnt increase on the rural interstates was accocmpanied by a nonsignificant decrease of 456 accidents in the entire state of Alabama. This confounding results made it difficult to isolate the cause of various significant changes, but the overall evidennce is not favorable to the recent increases in driving speeds

496502 DA

THE SAFETY IMPACT OF THE 65 MPH SPEED LIMIT - A TIME SERIES ANALYSIS. FINAL GRANT REPORT

Pfefer, RC; Stenzel, WW

Northwestern University, Evanston Traffic Institute, 405 Church Street Evanston Illinois 60208; National Highway Traffic Safety Administration 400 7th Street, SW Washington D.C. 20590

Dec 1989 132p Figs. Tabs. 6 Ref. 5 App.

REPORT NO: HS-807 524

CONTRACT NO: DTNH22-88-Z-07192; Contract

SUBFILE: HRIS; HSL

AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161

The project examined the effects of the national maximum speed limit change on vehicular speeds and safety on 1200 miles of rural interstate highways in the state of Illinois, where the increase from 55 to 65 mph occurred in May of 1987. The speed limit increase does not apply to trucks. Analyses were made of speed data from four individual speed monitoring sites, and the aggregate of 15 sites, on rural interstate roads. The results indicate that there was an increase in the 85th percentile speed of passenger vehicles, on the order of four, or five, miles per hour, correlated with the change in the law There was not similar evidence of any change in truck speeds. There was also no strong evidence that the speed variance was affected by the law change. The frequency of all accidents increased on the order of 14%, in correlation with the law change. However, the same evidence could not be found for increases in either the frequency of serious accidents, or the accident rate. Furthermore, there was no strong evidence that speed differentials between trucks and cars were affected, or the car-truck accident experience changed.

474800 DA

TRAFFIC CONTROL AND ACCIDENTS AT RURAL, HIGH-SPEED INTERSECTIONS. FINAL REPORT

Agent, KR

Kentucky University Kentucky Transportation Research Program Lexington Kentucky 40506; Kentucky Department of Transportation State Office Building, Clinton and High Streets Frankfort Kentucky 40622; Federal Highway Administration 400 7th Street SW Washington D.C. 20590

Mar 1987 131p 1 Fig. 23 Tab. 55 Ref. 2 App.

REPORT NO: UKTRP-87-6

CONTRACT NO: KYHPR-86-114, Contract

SUBFILE. HRIS

AVAILABLE FROM: Kentucky University Kentucky Transporation Research Program Lexington Kentucky 40506

The site characteristics, traffic control used, and accidents occurring at 65 rural, high-speed intersections were summarized. The differences resulting when the right of way is controlled by stop signs versus a traffic signal are discussed. The factors contributing to the accidents as well as the characteristics of the accidents were analyzed. The data obtained at each intersection were summarized and recommendations, which could be used as a guide for implementing changes at other similar intersections, were made for the study locations. The accident analysis shows that providing the driver adequate warning of the intersection is of primary importance for this type of intersection. At signalized intersections, the need to provide a proper change interval and maximize the visibility of the signal heads are essential. The need to consider separate left-turn phasing also is shown.

334169 DA

TRANSVERSE PAVEMENT MARKINGS FOR SPEED CONTROL AND ACCIDENT REDUCTION (ABRIDGMENT)

Agent, KR (Kentucky Department of Transportation)

Transportation Research Board

Transportation Research Record N773 1980 p 11 9 Ref.

SUBFILE. HRIS

AVAILABLE FROM: Transportation Research Board Publications Office 2101 Constitution Avenue, NW Washington D.C. 20418

Transverse pavement markings were placed ahead of a sharp curve that had a history of high accident rates Before-and-after studies of speed and accidents were conducted. The markings were placed so that drivers who failed to slow when approaching the curve would see the transverse lines on the pavement at an increasing rate. The spacing of lines was intended to create an illusion of acceleration that would cause the driver to slow. The results indicated that pavement markings can be an effective speed-control measure and reduce accidents. At the single site studied, the obedience of drivers to this type of hazard warning was more effective than signing alone. Further use of this type of marking may be warranted at locations at which excessive speed contributes to accidents. The length or roadway marked in this trial was 247 m (810 ft). Although the striping tape performed satisfactorily, painted lines could be used as an alternative. (Author) This paper appeared in Transportation Research Record No. 773, Grade Crossings, Devices, Visibility, and Freeway Operations.

485336 DA

VARIABLE SPEED LIMIT SYSTEM COST BENEFIT ANALYSIS. FINAL REPORT

RJO Enterprises, Incorporated 4550 Forbes Boulevard Lanham Maryland 20706 ; Federal Highway Administration Turner Fairbank Hwy Res Cntr, 6300 Georgetown Pike McLean Virginia 22101

May 1989 40p

REPORT NO: FHWA-RD-89-004; NCP 3A1d0082

CONTRACT NO: DTFH61-88Z-0082; Contract

SUBFILE: HRIS

AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161

The variable speed limit (VSL) system is designed to display both the maximum and minimum speed boundaries based on measured traffic and environmental conditions. In addition, short driver information messages can be displayed to warn of downstream conditions The VSL can be installed to operate independently (Isolated), in a series of stations (Linked), as a component of a larger management system (Integrated), and in the future as part of an "In-Vehicle" component to provide all types of driver information (In-Vehicle). This analysis compares the four types of VSL systems to the existing "fixed" speed limit system which can display only one speed for all conditions The costs of the VSL equipment include its installation and maintenance, the costs of accidents include accident-induced delay costs, and time costs include time to traverse the section. A number of assumptions are made relating to projected accident rates, traverse time costs, and drivers' responses to the system. The model, using Lotus 1-2-3, calculates the costs and benefits for the set of roadway, traffic, and weather conditions entered by the user Four scenarios were run, one for each of the VSL types using actual site information. The benefit--cost ratios computed were 37 to 1 for the isolated system, 22 to 1 for the linked system, 55 to 1 for the integrated system, and 53 to 1 for the in-vehicle These ratios are very sensitive to the assumptions made where actual data were not available.

607231 DA

VEHICLE CRASHWORTHINESS AND OCCUPANT PROTECTION IN FRONTAL COLLISIONS. THE SIGNIFICANCE OF FRONTAL OFFSET COLLISIONS IN REAL WORLD ACCIDENTS. SAE INTERNATIONAL CONGRESS AND EXPOSITION, FEBRUARY 26-MARCH 2, 1990, DETROIT, MICHIGAN

Pletschen, B; Herrmann, R; Kallina, I; Zeidler, F

Society of Automotive Engineers 400 Commonwealth Drive Warrendale Pennsylvania 15096 1-56091-016-X

Feb 1990 pp 11-16 Figs. Refs.

REPORT NO: SP-807

SUBFILE: HRIS

AVAILABLE FROM: Society of Automotive Engineers 400 Commonwealth Drive Warrendale Pennsylvania 15096

The most important factors to consider in order to improve the level of occupant protection measures are those determined through the investigation of real world accidents. The distribution of various types of collision and impact speeds provides a sound basis for more realistic test procedures. One result of our in-depth accident investigations is the identification of the frontal offset collision with only partial overlap as the most frequent frontal accident with injured occupants. Based on that an additional frontal impact test procedure carried out with 40% overlap at test speeds up to 55 km/h was derived. The effectiveness of offset design is verified by the analysis of actual accident data.

559877 DA

WHEN DID A REDUCED SPEED LIMIT SHOW AN EFFECT?: EXPLORATORY IDENTIFICATION OF AN INTERVENTION TIME

Helfenstein, U

Accident Analysis and Prevention Vol. 22 No. 1 Feb 1990 pp 79-87

SUBFILE: UCITS; TLIB

No abstract available.

Speed Environment Design Workshop, Canberra, November 1992

SPEED MANAGEMENT in NSW: AN OVERVIEW

Peter Croft
Manager, Road Environment Safety
Road Safety Bureau, Roads and Traffic Authority, NSW

INTRODUCTION

In 1986 the then Traffic Authority of NSW began a comprehensive program for tackling the speeding problem. This paper provides a brief overview of the program and activities to date, and outlines future program directions and requirements. It provides an update on a previous overview (Croft 1990).

THE SPEEDING ISSUE

An examination of accident data, particularly fatal accident files, together with the results of traffic surveys and the findings of behavioural research studies, suggested that significant safety improvements might be realised through mounting a comprehensive attack on excessive and inappropriate speeds. The evidence was that -

- excessive speed for conditions was implicated in around 40% of rural fatal crashes and around 30% of metropolitan fatal crashes.
- speed limits were widely disregarded in both rural and urban areas;
- speeds on urban streets were far in excess of the safe levels appropriate to residential areas;
- drivers acknowledged the dangers of excessive speed but continued to break the law;
- there was some community support for increased sanctions against such speeding behaviour.

This confirmed the long-held acknowledgement that excessive speeding behaviour is common and is a major contributor to the accident problem. It remained the largest single factor yet to receive intensive treatment of the type successfully employed for occupant restraint and drink-driving issues.

Drawing on successful experience with these other issues, it was acknowledged that the deep-seated nature of the speeding problem required that a long-term commitment be given to developing solutions for it.

The main avenues for speed control are through engineering, legislative, educational and promotional measures, each interacting with enforcement policies and practices. It was acknowledged as important to integrate activities in all such areas. An appropriate speed control package should be structured so that behaviour changes arise from attitudinal modifications as well as from driver adjustments to more tangible elements such as engineering and enforcement measures.

Earlier papers provide further details about the origins and approach of the program (Camkin & Croft 1987) and the particular implications for enforcement as an integrated component of an overall strategy (Croft 1988).

SPEED CONTROL STRATEGY

Results of a major attitudinal survey in 1985 supported the general view that excessive speeding is a widespread, deeply entrenched and socially condoned aspect of driver behaviour - just as drink-driving had been. Commitment of a substantial effort in tackling the problem was therefore required. This had proved essential for previous major road safety initiatives (for belt-wearing and drink-driving) similarly aimed at modifying entrenched attitudes and behaviour.

It was acknowledged that the program should capitalise on the unity of purpose and co-ordination, particularly between the road/transport and Police administrations, that had developed during the RBT program, and had underpinned its success. In particular, a co-ordinated approach to tactical planning of enforcement operations within an overall deterrence strategy was seen as offering the greatest potential for achieving the desired outcome - an eventual reduction in inappropriate speeds.

An appropriate strategy was identified as one based on a general deterrence approach to behaviour modification through a program involving public education, attitude change, specific visible enforcement, and targetted promotion. This was to be accompanied by continued development of appropriate engineering and legislative controls.

It was also acknowledged that the strategy itself must be consistent with the proven road safety program approach encompassing information, warning, action and follow-up. The major elements of the strategic approach were identified as follows:

(a) Long-term framework
    Public education through advertising, to address beliefs and attitudes, and provide a basis for persuasion to change; continual monitoring of knowledge and attitudes.

(b) Medium-term reviews
    Examination and rationalisation of policies, procedures and practices (e.g. limits, zoning, engineering, regulations, penalties) to improve control mechanisms.

(c) Short-term initiatives
    Specific targetted enforcement activity, with appropriate warnings and action, and associated publicity, to reinforce particular issues; monitoring and evaluation of effects.

SPEED REDUCTION CAMPAIGN

In mid-1986 the New South Wales Government launched the first phase of the long term program to reduce excessive speeding. The central objective was to decrease the number of traffic crash casualties in which excessive and inappropriate speed are contributing factors. This was the first time a long-term, well funded program on speeding had been implemented in Australia.

Prior to the launch, some changes were also made to the penalties and demerit points incurred for speeding offences, and an initial trial of Police aerial surveillance for speed enforcement was conducted.

Initial Publicity

The first phase of the program involved a substantial publicity component seeking to:

- raise community awareness of speeding as a safety problem and of the need to reduce speed to levels appropriate for conditions;
- remind road users of the increased penalties for speeding offences;
- build a platform for a strong deterrence-based approach.

The strategy adopted was to use a soft approach initially in the publicity material in acknowledgement of the entrenched and socially acceptable attitudes condoning excessive speeding behaviour. The campaign, utilising the **"Take It Easy"** message, was established and served as the basis for various specific initiatives to be introduced over the ensuing years.

In addition to substantial advertising on television and radio, and in various print media, the campaign was supported by a range of publicity materials and activities which promoted both the campaign itself and specific initiatives.

Enforcement Issues
Previous campaign experience had underscored the importance of having both enforcement and publicity activities operating together, in order to raise the public perception of a serious and well orchestrated attack on the problem. In the light of this experience, the next phase of publicity for the speed reduction campaign concentrated on enforcement issues.

During 1987 aerial speed surveillance was introduced, new radar speed meters were brought into service, enforcement "tolerances" for speeding offences were reduced, and the use of accident blackspot information as a basis for radar patrol locations was widely publicised.

NEIGHBOURHOOD ROAD SAFETY

In 1984-85 the Traffic Authority of NSW had initiated a comprehensive Neighbourhood Road Safety Campaign to improve the community's awareness of traffic safety on local urban streets, where traffic intrusion and speeding were acknowledged problems. The campaign was conducted in ten local government areas around the state and included media activities, distribution of materials, and community relations activities. Evaluation included assessment of changes in community awareness and driver behaviour. The results (Samdahl & Daff 1986) showed that while there were no significant changes in awareness or behaviour, the campaign had been successful in focussing attention on speeding and revealed that local speed control devices were becoming more acceptable to the public.

During the same period, a trial of 40 km/h speed limits in local residential precincts was conducted in several local government areas in Sydney. Attitudinal surveys and measurements of traffic volume and speeds were undertaken to assess the effects of the speed limits - alone, and in combination with physical speed control devices - on the community. The trial indicated (Webster & Schnerring 1986) that vehicle speeds could be reduced in local streets where the speed limits were applied in conjunction with physical devices. There was also community support for this local area traffic management approach, particularly in areas where residents had been exposed to the Neighbourhood Road Safety Campaign.

This experience was brought together in the publication of guidelines for Neighbourhood Road Safety (Traffic Authority 1987). These included revised general guidelines for local area traffic management (LATM) schemes in residential areas, guidelines for 40 km/h speed limits in local precincts and guidelines for special shared traffic zones bearing a speed limit of 10 km/h.

SPEED ZONING REVIEW

A comprehensive review of the principles and practice of speed zoning in New South Wales was undertaken during 1987-88, with a view to ensuring that the relationship between speed limits and the road environment is credible and consistent. Such a review was seen as a prerequisite to any future introduction of measures aimed at modifying speeding behaviour and maximising compliance with speed controls.

The review was aimed at providing a publicly acceptable system of speed control measures, and addressed urban and rural roadways, speed limits, speed zoning, advisory speed signing and enforcement practices. Attention was given to the identification of typical anomalies and inconsistencies that appeared to exist in practice with regard to such speed controls. Various proposals to address these were identified and examined in the light of current standards and guidelines.

The review (Traffic Authority 1988) produced several recommendations for changes to current practice regarding the setting and monitoring of speed controls. These ranged from specific proposals for amendments to signposting methods (some of which were already emerging in practice), through Statewide changes to zoning approaches (in both urban and rural areas), to suggestions which have national implications.

The NSW manual on speed control policy and practice was extensively revised to reflect the amended practices. Essential features of the revised document were:

- greater choice in selecting values for speed limits (for example, 70 and 90 could be used in addition to 60, 80 and 100 km/h)
- greater flexibility in the determination and application of speed zones (for example, opportunities were extended for application of these intermediate speed limits on urban arterial routes)
- greater emphasis on topography and road alignment in setting speed limits (for example, lengths of rural road with substandard alignment could be speed zoned below the general limit rather than relying only on extensive use of advisory speeds)
- greater emphasis on accident experience as a basis for setting speed limits (more detail on critical accident rates was provided, and less reliance was placed on observed 85 percentile speeds).

The revised guidelines were issued in late 1988 (Department of Main Roads 1988) and a plan for the implementation of revised zoning practices was subsequently developed and pursued during 1989 and 1990.

Rezoning proceeded with the most notable changes being the introduction of 70 km/h limits on some urban arterials, and the use of 80 and 90 km/h zones on some sub-standard sections of rural arterials.

The review also recommended a trial of 110 km/h speed limit zones on selected roads in the far western regions of NSW, and further experimental evaluation of special part-time speed limits outside schools; these are discussed later.

Examination of the current 60 km/h general urban speed limit was deferred pending national consideration of the implications of any proposal to lower it. Consideration of proposed changes to advisory speed signing practice was deferred in favour of higher priority issues.

THE SPEED PACT

The Speed Reduction Campaign was re-launched in mid-1988 as a Pact between the Government and the motoring public. The Speed Pact sought to promote the concept of an accord between the then Traffic Authority (who agreed to reassess the existing speed zoning system), the motorist (who agreed to comply with the revised speed limits), and the Police (who agreed to audit motor vehicle speeds and enforce compliance with speed limits as necessary).

The two essential features of the Pact were:

- introduction of the revised procedures for speed zoning which placed more emphasis on accident experience and road features and enabled greater flexibility in achieving consistent and acceptable speed limits;
- a re-launch of the speed reduction advertising campaign with a focus upon promoting stricter compliance with speed limits through enforcement, especially visible enforcement; radio and television advertisements emphasising these aspects were produced in late 1988.

The original 'Take it Easy' advertising campaign was designed to highlight speeding as a major road safety issue, while at the same time promoting enforcement and alerting drivers to the penalties for speeding. Maintaining credibility of the speed reduction program, and its enforcement, was seen as the basis of the attitudinal changes sought via the campaign. A central thrust of this approach was to convince the public that both the campaign itself, and the various aspects of its enforcement, were being pursued for very sound road safety reasons rather than for those of revenue-raising.

An evaluation of the campaign revealed that although it had some impact on the community in terms of making people more aware of speeding as a major factor in road accidents, there were indications that the campaign needed new emphasis in order to sustain that impact.

While the advertising campaign accompanying the Speed Pact had high levels of recall amongst motorists and increased some people's perception of enforcement activities, a substantial proportion of drivers still perceived that there had been no increase in enforcement. Another major attitudinal survey was conducted in late 1988, in which a majority of motorists - the same proportion of motorists as in the 1985 survey - reported that they exceeded the speed limit.

It became clear therefore that the reduction of excessive and inappropriate speed behaviour remained an area requiring considerable further attention and effort.

During 1989, further initiatives included the extensive use of "camouflage" police vehicles for speed enforcement, and the development of a new series of advertisements and accompanying brochures. These advertisements, relying heavily on television and billboards, and using the line "There's No Future in Speeding", emphasised both the financial (penalties) and human (personal suffering) consequences of speeding.

ENVIRONMENTAL ADAPTATION

During the late 1980s, the RTA supported research on the conflict between pedestrians and vehicles in areas such as shopping precincts on metropolitan sub-arterial routes or in the main streets of country towns. Studies examined the details of such conflict, particularly the vehicle speed profiles in such precincts, and proposed solutions involving adaptation of the physical environment. These solutions include not only traffic management arrangements but also local planning considerations; the treatment approach is known as "environmental adaptation".

Research on environmental adaptation of linear shopping precincts on urban sub-arterial routes resulted in provisional guidelines (Roads & Traffic Authority 1989) and provided the basis for proceeding with demonstration projects aimed at testing in practice the concepts and solutions proposed. More recent work emphasised the country town main street situation and extended the research to produce practical guidelines and criteria not only for environmental adaptation of precincts but also for the conduct of demonstration projects (Armstrong et al 1992).

The work established principles for planning and designing the environmental adaptation of main streets, including a comprehensive schedule of possible treatments for controlling the speed environment in such precincts. Pilot demonstration projects are currently in progress.

HEAVY VEHICLE SPEED LIMITS

Following an unusually high involvement of heavy vehicles in fatal crashes during 1988, and the occurrence of two multiple-fatality heavy vehicle crashes involving coaches in 1989, NSW lowered the maximum speed limit for all heavy vehicles to 90 km/h. This took effect early in 1990, but the requirement was soon relaxed by the introduction of a concession for heavy vehicles fitted with speed limiting devices. Such vehicles, bearing appropriate marker plates, were permitted to travel at speeds up to 100 km/h on specially designated sections of roadway which were signposted accordingly. These provisions still apply.

A series of speed surveys undertaken in 1991 monitored point-to-point journey speeds along common heavy vehicle routes, and free speed surveys of speed-limited and non-speed-limited heavy vehicles. These surveys showed (Johansen 1992) that in the absence of evident enforcement, excessive heavy vehicle speeds remained prevalent, even for those vehicles supposedly restricted by speed-limiting devices.

SPEED MANAGEMENT PROGRAM

In early 1990, the progress of the Speed Reduction Campaign was reassessed as part of the development of a rejuvenated Speed Management Program. A fundamental objective was reaffirmed - that of seeking to increase the degree of voluntary compliance with speed limits within urban and rural zones, by:

- increased knowledge of the penalties for speeding;
- increased perception that these penalties are harsh;
- increased perceived enforcement of speed limits; and
- increased respect for, and compliance with, speed limits as the sensible and safe maximum speeds.

It was considered that this objective could be achieved via strategies including -

- a multi-media advertising campaign highlighting increased enforcement activities and the penalties for speeding;
- increased visibility of Police activities in apprehending drivers exceeding the speed limit and driving at speeds inappropriate for the conditions; and
- the promotion of revised speed zoning practices.

Static Deterrence Program

In mid-1990, there commenced in the North Coast region of NSW a program of randomly allocated static Police enforcement patrols known as the Static Deterrence Program. The aim of the exercise was to increase the perceived level of active enforcement, and was modelled on earlier experiments in Tasmania although applied over much greater lengths of highway; approximately 350 km of highway served as an experimental section with a similar length acting as a control section.

Evaluation included an extensive series of speed surveys (Roads & Traffic Authority 1990), an analysis of crash experience, and a special questionnaire survey of both Police operators and road users. The results (AGB Australia 1991) from speed and accident surveys indicated no significant change in speeding or accidents. There was no clear indication from road user surveys that the program had achieved any effect, and Police officer surveys revealed several operational difficulties which detracted from the original design of the study.

Advertising and Publicity

A program of advertising, using the Victorian TAC television material as a basis, was developed in late 1990 to raise consciousness of the speed/accident relationship. It was intended that through the use of some emotionally striking material the target audience would begin to internalise the experiences typically associated with speed-related accidents. In addition, a series of radio-based advertisements was developed to further emphasise the deterrence and human consequence aspects.

Monitoring and Evaluation

Evaluation of the speed management campaign activities was addressed by the development of a comprehensive program including crash data analyses, and utilising augmented speed survey measurements and questionnaire surveys.

Towards the end of 1990 there was conducted another attitudinal survey, supplementing the major surveys conducted in 1985 and 1988; special attention was paid to the imminent introduction of radar speed cameras and the proposed banning of radar detectors. A further major attitudinal survey was conducted in 1991.

The established series of statewide speed survey measurements provides twice-yearly tracking of trends in free speed distributions (Norrish 1993). These will be augmented in future to include additional sites for particular classes of urban roads to assist with evaluation of particular campaign initiatives, such as speed cameras.

RADAR SPEED CAMERAS

Radar cameras were introduced within metropolitan locations immediately before the Easter period 1991. The radar cameras are used in areas of adverse crash history or excessive high speed and were initially restricted to areas where, because of safety factors, traditional enforcement methods could not be used. Their introduction was accompanied by signposting of selected roadways where radar cameras may be operating and an extensive publicity campaign.

Advertising and publicity activities facilitated the introduction of radar cameras through education about speed zoning activities and speed limits. They also focused on giving the community information about radar cameras as a new enforcement tool, and emphasised the objective of increasing compliance with posted speed limits. As expected, following the Victorian experience, this was accompanied by heavy commercial media attention. A one month "public education" period was declared during which enforcement activities took place but offenders were not prosecuted. Omnibus questionnaire surveys were conducted once before and twice after the introduction of the speed camera operations.

An interim evaluation of the program (Roads & Traffic Authority 1992), based on attitude surveys and speed surveys, indicated a small but positive effect in reducing high speeds, and a strong level of public support for the program.

SPEED ZONING IMPLEMENTATION

As foreshadowed in the Speed Pact, rationalisation of the speed limit system through the revision of speed zoning, was seen as a prerequisite to effective public support for the speed management program. It was regarded as particularly important for the acceptance of the introduction of the radar speed camera program, lest this be seen to be primarily a revenue-raising activity.

Review and adjustment of speed zones occurred during 1989 and 1990 so that by the introduction of radar speed cameras in early 1991 the zones on the majority of major roadways had been revised; those in the Sydney metropolitan area were less complete than in other areas. Specific aspects of the speed zoning revision are as follows:

110 km/h Zones

While the speed zoning review provided for the application of 110 km/h zones to high standard divided carriageway sections (even if not fully access controlled freeway conditions), their application to low-volume undivided two-way roads was subject to a trial during 1989-90 on selected sections of highway in the far west NSW region. The trial indicated that introduction of the 110 km/h zones was associated with a small increase in vehicle speeds, but the degree of compliance with the higher limit was greater than for the 100 km/h limit which applied previously (Soelistio 1990).

The 110 km/h zones were extended on suitable sections of undivided roadway and formal guidelines for their application were drafted. Analysis of accident experience associated with this extension of zoning is currently in progress.

School Zones

An opportunity arose within the North Coast region of NSW for a trial of part-time speed limits outside schools. Typically these were 40 km/h or 60 km/h zones in otherwise higher speed zoned sections, and applied during school arrival and departure times only. Other treatments such as flashing lights and kerb realignments were used at some sites. An evaluation study (Swaminathan 1992) showed a reduction in speeds in some circumstances, and indicated a large degree of support among the community for such speed controls.

During mid-1992 a decision was taken to introduce special school speed zones throughout the state. Guidelines for these were drafted and their introduction commenced during late 1992.

Technical Review of Speed Zoning

During 1991 a technical review was undertaken of the speed zoning in place in NSW. The purpose was to assess the appropriateness of zoning, identify the extent to which the revised guidelines had been implemented, to examine departures from the guidelines, and to assess the need for any further revision of the guidelines in the light of experience. The review (Soelistio & Li 1992) indicated that zoning was generally appropriate, and pointed to some detailed aspects of zoning, including signposting and pavement marking, which needed attention further revision of the guidelines.

Buffer Zones
The 1988 speed zoning review had recommended that speed limit "buffer zones" (typically 80 km/h zones inserted between the 100 km/h highway limit and the 60 km/h limit in a country town) be phased out. In view of the inclination to retain these in some other states, a study to compare their effectiveness with other approaches was commenced by ARRB in 1992 and is currently in progress.

NLIMITS
The development of a computer-based expert advisory system entitled NLIMITS was commenced in 1991-92. Its purpose is to assist practitioners in the setting of speed limits in accordance with the policies and practice in NSW, and it is based on a similar advisory tool VLIMITS developed by the ARRB for Victoria. A test version is currently under review by speed zoning practitioners in the RTA.

Consolidated Zoning Guidelines
In late 1992 work began on the preparation of new consolidated guidelines for speed zoning which will incorporate recent initiatives (school zones, 110 km/h zones), results of the technical review, outcomes of the buffer zone study, and use of the NLIMITS advisory tool.

URBAN SPEED MANAGEMENT

One aspect of the current implementation of revised speed zoning in need of discussion in a broader context is the hierarchy of speed limits across the urban road network. Speed zoning practices on urban roads should be considered in the context of a broad urban speed management strategy.

Urban areas, particularly major metropolitan and provincial centres, span a wide range of roadways both in terms of their physical formation and the transport/traffic functions they provide. Speed management measures also cover a wide range from the statutory general urban speed limit, through the application of speed zoning, to local area traffic management treatments and urban road design practices.

While major traffic routes are typically speed zoned above the general limit, and local area precincts are increasingly being introduced with lower areal speed limits, the vast majority of the urban road network is subject to the general limit of 60 km/h. This majority of the network nevertheless covers a wide range of road types and functions, on some of which the motoring public sees the application of the general urban speed limit as inappropriate.

It is appropriate, therefore, to include a review of the general urban limit in the development of an urban speed management strategy. Not only is the general applicability of the limit across a wide variety of road types to be questioned, but in view of practices and experience overseas, the level at which the general limit is set needs close examination. It is noted that the Australian general urban speed limit is among the highest in the world.

Already there is much discussion of this in individual jurisdictions, and a project has now been established under the Austroads road safety program whereby this matter can be examined from a national perspective.

STRATEGIC SPEED MANAGEMENT PROGRAM

During 1992, a new strategic program for managing the speeding problem was developed by the RTA, in conjunction with major stakeholders (Police, NRMA) and others represented on the Road Safety Advisory Council (RoSAC).

The ultimate objective is to achieve a situation where -
- the road environment and speed zones are appropriate
- drivers comply with posted speed limits
- speeds travelled by drivers are appropriate for the prevailing conditions

The vision held for speed management in the future is that -
- Speeding Behaviour will be as closely controlled as drink-driving, be appropriate for prevailing conditions, and reflect that excessive speed is socially unacceptable;
- Speed Management will be achieved via a comprehensive strategic program, require an appropriate physical environment, involve a publicly acceptable regulatory environment, and be achieved largely by voluntary compliance

Essential elements of an appropriate speed management program were identified as -
- increased public education and awareness
- extended LATM treatments
- promotion of speed zoning
- review of general urban speed limit
- extended speed camera activity
- review of penalties and offences system
- application of emerging vehicle/road technologies

This is being approached by developing a comprehensive communications strategy which will underpin the whole program (Frape 1992). Important early phases of the program focus on raising awareness of this issue among the community by stimulating informed public debate, and on pre-selling the issues to stakeholders. These activities are currently in progress.

THE FUTURE

During 1993 the pre-selling of program objectives will continue, in parallel with further development of detailed strategies and action plans. Promotion of an informed dialogue with the community through advertising and carefully planned media coverage of the issue will be central features. Market research and technical development of engineering and enforcement initiatives will continue in support of specific campaign launches in accordance with the overall strategy.

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POSTSCRIPT (June 1993)

During the first few months of 1993, there has been a significant acceleration of the program. A community advisory group was established to act as a means of eliciting and consolidating community comment on component aspects of the speeding issue. Comprehensive market research and concept testing has been undertaken to develop suitable advertising and educational material. A publicity campaign has been launched, announcing initiatives in the areas of driver education and training, speed limits and speed zoning, enforcement of speeding behaviour, speeding offences and penalties, and public education. Notable features include a comprehensive radio and outdoor advertising campaign, an acceleration of revised speed zoning, a hastening of the program for introducing school speed zones, an extension of local area speed zones, a new official cautions system for minor speeding offences, a coordinated police publicity campaign emphasising the prevalence and high visibility of speed camera operations, and the development of a community information package.

MONASH UNIVERSITY ACCIDENT RESEARCH CENTRE

SPEED RESEARCH AND CURRENT ISSUES IN SCANDINAVIA

Paper presented at Speed Environment Design Workshop, Canberra, November 1992

Max Cameron, Senior Research Fellow

1. INTRODUCTION

Monash University Accident Research Centre is carrying out a research project on *Speed and the Environment* for the New South Wales Roads and Traffic Authority and the Federal Office of Road Safety. Part of that project involves gathering information from overseas countries, with particular emphasis on the role of speed in four relevant areas:

1. Environmental Influences
2. Speed and Crashes
3. Speed Limits
4. Behaviour and Enforcement.

Sweden has long been recognised, together with Canada and New Zealand, as a country to which close attention should be paid when determining an appropriate parallel to Australian conditions so far as speed and speed management issues are concerned (Cumming and Croft 1971). For this reason, the writer was commissioned to seek information on Swedish research and practice in the speed area during a visit to Europe in September 1992.

AUSTROADS has established a project team to review the relevance of the present general speed limit of 60 kmh in urban areas in Australia, in the context of developing an urban speed management strategy and of the level of public credibility of speed limits generally. As background it was noted that by international standards, amongst highly motorised countries, Australia has a very high general urban speed limit, in comparison with the state of development of its arterial road system.

The general urban speed limit in Denmark was reduced from 60 kmh to 50 kmh in 1985. This change was made against the background of a progressive approach to urban speed management in that country, through the use extensive speed zoning, local area traffic management treatments, and urban road design, as well as general speed limits. For this reason, the writer was also commissioned to seek information on Danish experience and practice in urban speed management.

Table 1 shows the general speed limits applicable to urban areas, highways and freeways/motorways in western European countries. This shows that the urban general speed limit has been set at a consistent 50 kmh level (30 mph, or 48 kmh, in Great Britain). The Scandinavian countries have also been consistent in setting their highway general limits at 80 kmh. However the general limits on freeways/motorways vary considerably in Scandinavia, ranging from 90 to 120 kmh within and between countries.

Table 1: General speed limits in European countries (kmh)

country	urban area	highway	freeway
Belgium	50	90	120
Denmark	50	80	110
Finland	50	80	100-120
France	50	90	110-120
Great Britain	48	92	112
Greece	50	80	100
Holland	50	80	100-120
Italy	50	90	110
Spain	50	90	110-120
Norway	50	80	90
Germany	50	100	130-
Sweden	50	80	90-110

2. SOURCES OF INFORMATION

2.1 SWEDEN

Information in the form of personal communications and reports was obtained from:

- Mr Göran Nilsson, Head of Traffic Safety Research, Swedish Road and Traffic Research Institute (VTI), Linköping

- Mr Per Wramborg, Senior Traffic Planner, City Council of Linköping

- Professor Claes Tingvall and Mr Anders Kullgren, Research Department, Folksam Insurance Group, Stockholm.

2.2 DENMARK

Useful background to recent developments in Denmark was obtained from papers in a special issue of the journal *Accident Analysis and Prevention* on "Speed Management Through Traffic Engineering" (February 1992), which in turn emanated from a conference on *Speed Management in Urban Areas* held in Copenhagen in May 1990 (Road Directorate 1990).

In Copenhagen, information in the form of personal communications and reports was obtained from:

- Dr Lene Herrstedt and Mr Michael Nielsen, Traffic Research Division, Danish Road Directorate, Herlev (the visit also included a site inspection tour of speed management treatments in Copenhagen and the North Zealand area; see photographs in Appendix C)

- Mr Niels Helberg and Mr Hans Lund, Danish Council for Road Safety Research, Gentofte (Ms Ulla Engel and Mr Lars Thomsen, who conducted a number of evaluations of speed management changes during the 1980's, have since left the Council)

- Professor Niels O. Jorgensen, Institute of Roads, Transport and Town Planning, Technical University of Denmark, Lyngby.

2.3 SWOV REPORT

Another important source of information was an unpublished document "Speed and Safety: Research results from the Nordic countries" (Larsen et al 1990) written on behalf of SWOV in Holland and provided by Mr Göran Nilsson. This is a very useful summary of research on speeding issues published to the date of the report. The document is in four sections, one for each country (Denmark, Finland, Norway and Sweden) and each section generally covers the following topics.

- Speed and traffic flow
- Effects of speed limits on speed
- Effects of speed limits on accidents
- Behavioural factors affecting speed
- Effects of speed enforcement.

3. SWEDEN

The Swedish section of the SWOV Report is included in Appendix A. The sequential development of Swedish ideas and policy on speed management issues over recent decades has influenced the structure of this section of the present paper.

3.1 SPEED LIMITS

3.1.1 Effects of Speed Limits

Sweden had a number of changes in rural speed limits during 1968-72. This allowed a series of evaluations of the effects in terms of injury accident rates and injury severity (see Table 1 in Appendix A). Later, in June-October 1979, the 110 kmh speed limit on rural high standard two-lane roads and motorways was temporarily reduced to 90 kmh. Injury accident rates decreased by 24%, with even larger decreases in severe and fatal injury rates. More recently, in June-August 1989, there was a similar temporary reduction in the 110 kmh limit to 90 kmh. Injury accident rates decreased by 27% on the former 110 kmh roads, but there was also a decrease of 14% on the roads whose 90 kmh limit was unchanged (Nilsson 1990a).

The general finding from all these evaluations is that injury accident rates decrease with reductions in speed limits and, in addition, the severity of injury also decreases. The net effect is that the severe injury accident rates decrease more than the injury accident rates, and the fatal accident rates decrease even more than the former.

Of course, none of these decreases would have occurred had there not been a real change in speed behaviour associated with the speed limit changes, and the Swedish authorities were wise to measure this as well. Since the late 1970's, there has been a regular and on-going speed monitoring program conducted at a random sample of sites throughout Sweden, which are surveyed 3-5 times per year over a 24-hour period. These systematic surveys have provided the basis for linking actual speed changes to the changes in accident involvement and the injury consequences of accidents. This in turn has led to the development of empirical relationships which link changes in speed limits (and expected changes in average speeds) to changes in road trauma levels (for details see section 3.2.2 and Appendix B).

3.1.2 Speed Limit Setting

These relationships appear to be used for general speed zone policy, which in turn affects the speed limit set for a particular road section. A review of a range of possible objectives for speed limit systems (Nilsson and Roosmark 1977) suggested the following alternatives, ie. equalisation of:

- accident density (per kilometre of road)
- accident rate (per vehicle kilometre)
- accident costs (as a way of weighting the more severe outcomes)
- accident costs and vehicle costs (especially fuel consumption)
- transport economics (including travel time costs in addition to the above).

The objective of equalising accident rates was proposed by Nilsson and Roosmark, but with attention to be given to the more severe injuries which occur in some accident situations. Thus the objective was "to equalise the differences in accident rates and injuries within 'homogeneous' road categories [defined by road standard and traffic composition], by the application of differentiated speed limits". [Nilsson now favours the objective of minimising transport economics, where accident and injury cost savings must compete with travel time and vehicle costs (Nilsson 1992).]

Accident rates and injury severities for each category of road have been established (see table on page 7 of Appendix A). Note that the accident rate is lowest on the higher standard roads (which have the higher speed limits), but that the injury severity is more disparate due to the different accident types which can occur in different road categories (eg. divided compared with undivided roads). A refinement of this reference data has been to calculate injury cost rates to combine the accident risk and injury severity dimensions (Table 2, from English summary of Nilsson 1984).

Table 2: Personal injury cost per million car kilometres and median speed level in the road environments studied [from Nilsson 1984].

Road environment	Personal injury cost per million car km (SEK 1.000)	Speed level (km/h)
Rural motorway, 110 km/h	47	108
Urban motorway, 90 km/h	75	100
Undivided motorway, 110 km/	113	102
Two-lane road 110 km/h	149	100
Two-lane road 90 km/h	130	90
Two-lane road 70 km/h	126	80

A road section under consideration will first have its injury cost rate calculated, then it is compared with the reference rate for the category of roads in which the section apparently lies. If its rate is higher than the reference rate, the section is then placed in a category which provides a better match of the rates. The speed limit of the road category then determines the speed limit of the section. Thus a route may be divided into a number of sections which have different speed limits according to the injury cost rate observed on each of those sections. Apparently the traffic engineers pursue this approach, calculating rates for road sections excluding particularly troublesome sub-sections (eg. near junctions) so that a case can be made for a higher speed limit (as is appropriate) and accepting that local speed limits must be applied along the route at specific sub-sections where lower limits are warranted.

The treatment of special streets, such as shopping precincts and near schools, receives less attention from the question of appropriate speed limits, but rather aims to manage speed through environmental influences (see section 3.3).

3.2 SPEED AND CRASHES

3.2.1 Speed and Accident Risk

Information was sought from Göran Nilsson on research related to the role of travel speed in causing accident involvement. VTI recognise the equivocal nature of research results on this question and deliberately focus debate about speed control issues on the injury severity increasing role of speed. He went on to emphasise that in assessments of road trauma countermeasures, VTI always examine the effects in three conceptual dimensions:

1. Exposure (eg. vehicle kilometres)
2. Accident risk (measured by accidents per exposure)
3. Injury severity (measured serious injuries per accident).

Then the number of serious injuries = Exposure *x* Accident risk *x* Injury severity. Speed control measures have relatively certain effects on injury severity, and some measures may also reduce exposure. While the effects of a measure on accident risk may be unclear, if the measure does not increase risk, and reduces one or both of severity and exposure, then the number of serious injuries will be reduced. Nilsson suggested this framework as a useful way of categorising speeding countermeasures.

3.2.2 Relationships Linking Speed and Road Trauma

Within this framework, and based on the numerous evaluations of speed limit changes and the effects on speeds, accidents and their injury consequences (see section 3.1.1), Nilsson has developed a set of empirical relationships connecting changes in median or average speeds to changes in road trauma levels. The relationships given in Nilsson (1984) suggest that the change in the number of deaths depends on the fourth power of the relative speeds, serious injuries on the third power, and lesser injuries on the second power. Nilsson has subsequently revised the form of each (Appendix B), but they are essentially the same power relationships. It would seem that these relationships are generally accepted for speed limit policy setting in the Nordic countries (at least in Denmark as well as Sweden, according to the Danish Council for Road Safety Research) because "while they are empirically based, they seem to work" (Lund, personal communication).

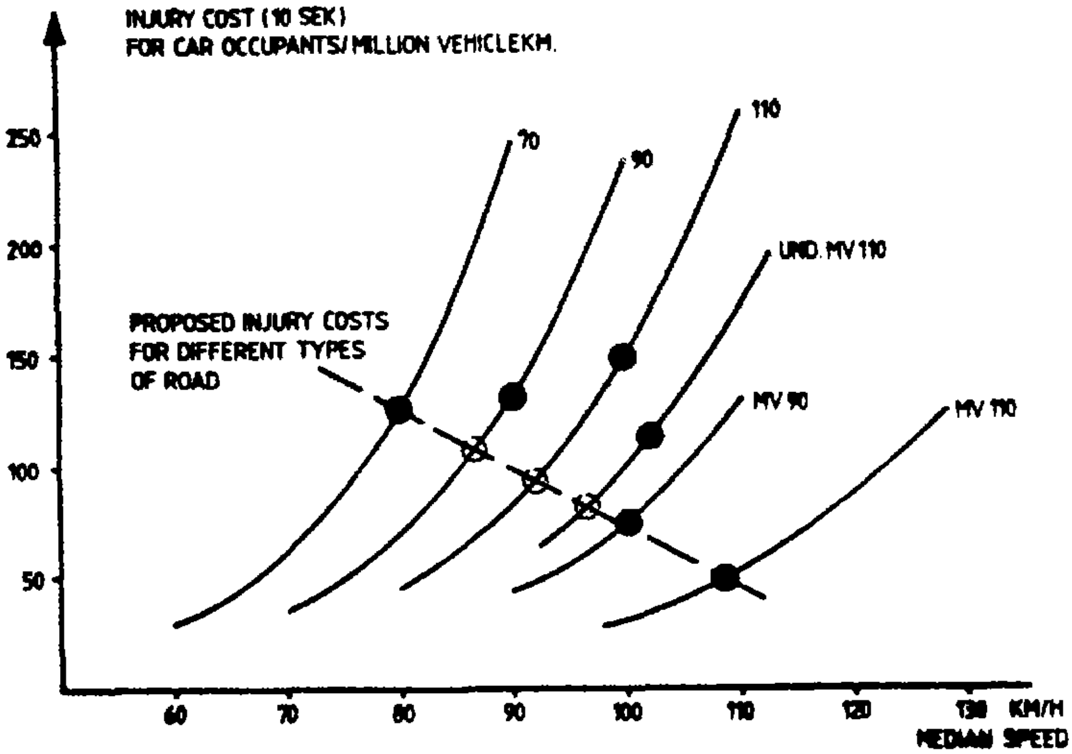
For example, the (earlier) relationships were used, in conjunction with the injury cost rates in Table 2, to make recommendations for reduced speed limits on rural two-lane roads and undivided motorways which were speed zoned at 110 kmh. Figure 1 from Nilsson (1984) shows that the injury cost rate versus median speed on those roads was unacceptably high compared with other road categories. With the then existing speed limit system, an increased standard of road had not always resulted in lower injury costs.

The curves fitted through each point are a cost-weighted composite of the three power curves described above. They indicate the median speed which would need to be achieved on the intransigent roads to bring those roads' safety performance down to a level (dotted circles in Figure 1) consistent with a standard reference line (this line accepts that lower standard roads have higher injury cost rates, and lower speed limits).

The relationships have also been used to calculate the effect on road fatalities of general changes in speed limits and associated enforcement policies, for example Nilsson (1990b) estimated a 45% fatality reduction if all speed limits were reduced by 10 kmh and the proportion of speeding infringements was halved (eg. by intensified enforcement and/or reduced tolerances). Hedman and Stenborg (1991), in developing a national road safety plan which aimed to reduce fatalities by 40% by the year 2000, apparently used the relationships to calculate that three-quarters of the total reduction could be achieved by a new speed control system with 10-20 kmh reduction in rural speed limits, heavily increased speed surveillance (up to five times as intensive), and reduced tolerance limits.

This proposed system was designed to be optimal in minimising transportation costs (Nilsson 1992). Carlsson and Nilsson (1992) have also used the relationships to calculate the road trauma consequences of a proposed increase in the truck speed limit in Sweden, including examination of the effects of various truck speed limiter settings.

Figure 1: Relation between personal injury costs for motorists per million car kilometres and speed level in different road environments [from Nilsson 1984].

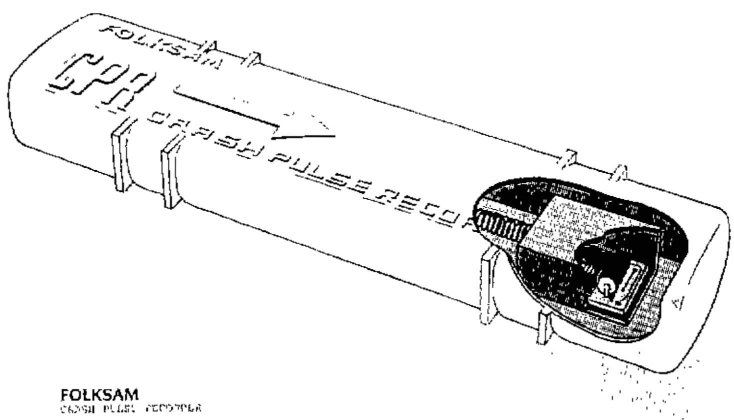


3.2.3 Crash Speed Recorders

The basis of research linking travel speed and accident risk in Australia would be technology which measures the speeds of vehicles involved in crashes objectively.

Folksam Insurance Group have developed a low cost (approximately $5 manufacturing cost) device for measuring the velocity change of vehicles involved in crashes (Aldman et al 1991). The change in velocity is measured in one direction only (usually longitudinally forward) and an accuracy of 2% compared with crash test accelerometers is claimed. The "Crash Pulse Recorder" (CPR) is a spring mass system (Figure 2) and when the mass is displaced a pulsating light emitting diode (LED) registers its location on a photographic film. Analysis of the film allows the displacement of the mass as a function of time to be plotted and the velocity change calculated.

Figure 2: Folksam Insurance's Crash Pulse Recorder



Folksam's motive for developing and installing the device in cars is to obtain velocity change readings as a basic parameter for assessing injury outcomes of car passengers in different crash circumstances and car designs. They have negotiated with five manufacturers/importers of cars in Sweden to provide cheap 3-year damage insurance packaged into the price of their new models, in return for which the CPR is installed in each car sold. The owner could remove the device, but very few do as they have apparently been persuaded that the readings from the CPR bear no legal relevance to their pre-crash driving speed (Tingvall said Folksam would refuse to cooperate in providing CPR results for legal purposes).

However, used carefully, the CPR results could certainly be used for research purposes to assess travel speeds before crashes in some crash situations. Tingvall agreed that the calculated velocity change would be correlated with travel speed in single-vehicle crashes, but cautioned that a correlation may not be present in multi-vehicle crashes due to the complexity of vehicle kinematics which typically occurs. There may also be a need for additional (uni-directional) CPRs to be installed in cars if velocity change over the full range of crash impact directions is to be measured.

3.3 ENVIRONMENTAL INFLUENCES

Discussions at the Linköping City Council and subsequent site inspections provided a good overview of how practicing traffic planners in Sweden use environmental design to supplement speed limits to control speeds, especially in urban and semi-urban areas.

Mr Per Wramborg described the deliberately planned hierarchy of roads in and around Linköping:

- E4 Motorway (110 kmh limit) providing long distance links to north and south
- Radial roads/highways (70 kmh; some 90 kmh), linking the motorway exits to:
- Outer ring road (70 kmh)
- Lower standard radial roads (50 kmh limit, plus clear visual appearance indicating this type of road has been entered), linking the outer ring road to:
- Inner ring road (50 kmh), whose main purpose is to get cars to parking places
- Inner roads (50 kmh limit, but the actual target speeds are much lower), designed to discourage motor traffic, with very clear visual signals that these have been entered, and encourage pedestrian and bicycle traffic.

The design of the inner roads has followed design principles developed in Denmark (see section 4.1) and Holland. The aim is to visually narrow the road space by the use of trees and lamp posts near the edge of the traffic lanes (photos 1-3 in Appendix C). A gateway effect is created at the entrance to the inner road treatment to emphasise the change in environment (photo 2). Within the inner road, various surface treatments are used to indicate to motor traffic that the environment is shared with pedestrians and cyclists (photo 4). Mr Wramborg emphasised that architects were included in the street planning so that they could be made beautiful and well as to achieve speed reduction and safety aims (this sentiment was echoed a number of times in Denmark also).

The inner road treatments shown in photos 1-4 have been evaluated in terms of their effects on traffic volumes, but not on speeds or reported accidents. As may be expected, motor traffic volumes have been approximately halved and it is claimed that it is now much easier for pedestrians to cross the roads. More comprehensive evaluations of such road treatments have been conducted in Denmark (see section 4.3).

The site inspections also included an outer-suburban residential street where a novel bus stop was displayed (photo 7). The kerb had been extended on both sides so that when the bus is stationary at the stop, other traffic is prevented from proceeding in either direction. In the same area was a bus only road running behind and around the residential street system, providing safe access of bus passengers (especially children) to the rear of their homes without having to negotiate normal trafficked streets (photo 6).

3.4 BEHAVIOUR AND ENFORCEMENT

3.4.1 Choice of Speed

Göran Nilsson outlined some unpublished research by VTI in which three groups of drivers (defined by their self-reported "normal" speed range on a 90 kmh road) stated the importance of factors related to each of the questions *"Why not driving faster?"* and *"Why not driving slower?"* (see pages 12-13 of Appendix A). The responses to these questions give a good indication of important factors influencing speed behaviour, and how their relative importance changes for drivers in each speed range. There is concern that even the fastest drivers said they did not want to impede traffic in response to the second question.

The material on page 13 of Appendix A gives only part of the results of an important study on 90 kmh roads linking observed speeds with driver interview, vehicle and owner data (G.K. Nilsson 1989). The results given for cars with male owners show that different factors can account for statistically significant speed difference of up to 11 kmh. No such factors (with one exception) were found for cars with female owners, but a difference of the order of 27 kmh related to remaining journey distance was found for cars with owned by "legal persons" (presumably companies). The exceptional factor was paved width of road, which was statistically significant for each category of owner, and producing speed increases of 0.4-0.7 kmh for each metre of road width (this factor should be noted as an "Environmental Influence"; it is implicit in many of the practices described in section 3.3 above).

Comparisons across categories showed that cars owned by legal persons travelled at statistically significantly higher speeds (estimated 6 kmh higher) and that cars towing trailers travelled much slower (by 17 kmh when towing a caravan and 14 kmh when towing another type of trailer). Many of these results are similar and confirmatory of those found in a similar study of drivers observed and interviewed on rural and urban roads in Victoria (Fildes et al 1991).

3.4.2 Enforcement

A series of studies have been carried out to assess the effects of different (radar) enforcement levels and tolerance levels. The earlier studies are outlined on pages 14-16 of Appendix A (see also Andersson 1989), and some general conclusions are given at the top of page 14.

These studies suggested that enforcement levels must increase 3-5 times compared with existing levels for drivers to change their speed behaviour on rural roads. More recent studies in Linköping and Norrköping during 1989 examined the effects of massive increases in radar surveillance over a 6 month period (6.6-7.5 times increased hours and 7-11 times increased number of vehicles checked) (Andersson 1991). The proportions of vehicles exceeding 50 kmh limits fell by 17-46% and a substantial proportion of this effect carried over to the next year. Modest reductions in personal injury accidents (3-16%) were observed, whereas there were generally increases elsewhere. While the results from these two cities vary considerably, they are consistent with a substantial effect on speeds and injury crashes.

Göran Nilsson also described an experimental evaluation of speed cameras which is nearing completion. Some 33 camera installations have been monitored over 2 years and compared with matched control sites. Camera sites are at fixed locations and may cover one or both directions. Warning signs appear at the beginning of camera routes and no attempt is made to hide the camera boxes. Vehicle speeds have been monitored by following individual cars (some 2500 in total) travelling along each route and recording the speed every 10 metres. It has been found that the camera installations influence vehicle speeds over a distance of 500 metres before and after sites in urban areas, and over a distance of one kilometre in each direction from rural sites. An effect is apparent even in traffic directions not covered by the camera; apparently the camera box reminds drivers of the speed limit (and surveillance generally) even though there is no immediate threat of detection for speeding. A joint report from the Police and VTI is scheduled to be released in December 1992.

3.5 OVERVIEW OF SWEDISH RESEARCH AND ISSUES

Speed limit setting policy in Sweden is well developed. It has been based on careful consideration of objectives, on extensive research linking speed limit changes with speed behaviour, accident rates and injury consequences, and on empirical models of these links which are well-accepted in at least the Nordic countries. Use of environmental influences to reduce speeds in urban areas appears to be based on Danish and Dutch practice. Research on other factors influencing choice of travel speed in part confirms findings from similar research in Australia. A number of studies have shown links between the intensity of radar surveillance, enforcement tolerance levels and speeding.

The crash speed change recorder developed by Folksam Insurance may be suitable for research in Australia to establish the relationship between travel speed and crash involvement, at least for single-vehicle crashes.

4. DENMARK

A very noticeable feature of Danish traffic compared with other European countries visited in 1992 (Germany, Italy, Switzerland and Sweden) was the high proportion of bicycles in urban areas. Brindle (1992) reported that bicycles comprise 20 per cent of the vehicles on central Copenhagen streets, and that 27,000 bicycles per day cross the two main bridges into the city centre. The road system reflects this level of bicycle traffic, with most roads other than in quiet residential areas having a bicycle lane or a separate bicycle path between the road pavement and the footpath. Bicycle traffic represents a significant extra challenge to right-turning motorists (our left-turners) because this parallel stream of traffic has right of way over turning vehicles. The threat to the "unprotected" bicyclists (as well as to pedestrians) from motor traffic is also well recognised in Danish traffic planning and speed management. Bicyclists and pedestrians are collectively known as "light road users" and are treated as special forms of traffic.

Government taxes on new cars in Denmark are very high (more than doubling the import cost), apparently because of the absence of a vehicle manufacturing industry in the country. The vehicle population is relatively old compared with nearby northern European countries, and the cars are relatively small in size and engine capacity (with relatively low performance characteristics, such as acceleration and comfortable cruising speed).

4.1 SPEED LIMITS

4.1.1 Development of Speed Limits

The urban general speed limit in Denmark was reduced from 60 kmh to 50 kmh on 1 October 1985. Table 3 shows that this was preceded by a number of changes in general speed limits (both urban and rural), but that during the late 1970's and early 1980's there was an emerging realisation that urban speeds could not be managed by speed limits alone The 1978 change to the Road Traffic Act allowed "living area" streets (some with pedestrian priority) to be defined, with relatively low advisory speeds, and the 1981 *Catalogue of Ideas* for treating main roads through towns led to the initiation of "Environmentally Adapted Through Roads". Experience with a range of urban road treatments (eg. humps, staggerings, narrowings and gateways) installed in response to these initiatives has now been embodied in the *Urban Traffic Areas* road standards released in 1991.

Table 3: Changes in speed limits and speed management practice in Denmark

Date	**Change in Limits or Practice**	**New Speed Limits**
To 1953	General limits in place	40 kmh in urban areas 60 kmh in rural areas
July 1953	General limits removed	
1961	Temporary limits during summer week-ends and holidays	80 kmh on highways 100 kmh on motorways
1973	Limits in response to oil crisis	60 kmh in urban areas 80 kmh outside urban areas
March 1974	Permanent general limits re-introduced	60 kmh in urban areas 90 kmh outside urban areas 110 kmh on motorways
Nov. 1978	Danish Road Traffic Act section 40 (a) pedestrian priority streets ("living areas") (b) other "living area" streets, with no change in traditional priority to vehicles	 (a) 15 kmh advisory speed (b) 30 kmh advisory speed
March 1979	Reduced rural general speed limits	80 kmh on highways 100 kmh on motorways [still 60 kmh in urban areas]
1981	*Catalogue of Ideas* for treating main roads through towns released (Road Directorate 1981). Treatments to give light road users greater priority.	
Early 1980's	Trials of *Environmentally Adapted Through Roads* in 3 towns (with populations of 3000, 4000 and 1000 respectively)	Treatments aiming at target speeds of 40, 40 and 50 kmh respectively
1984	Trial of 40 kmh limit in local traffic areas	40 kmh on residential roads
Oct. 1985	**Reduced urban general speed limit**	**50 kmh in urban areas** (some speed zoning above the limit in towns)
June 1991	*Urban Traffic Areas* road standards released (Road Directorate 1991a,b)	
June 1992	Increased motorway speed limit	110 kmh on motorways

However at the time of the introduction of the 50 kmh urban general speed limit, the hierarchy of road functional classes and corresponding target speeds was apparently still being developed in Danish urban areas. While the ideas and planning guidelines were certainly well developed, their implementation was still in its early stages.

4.1.2 Current Speed Limit System

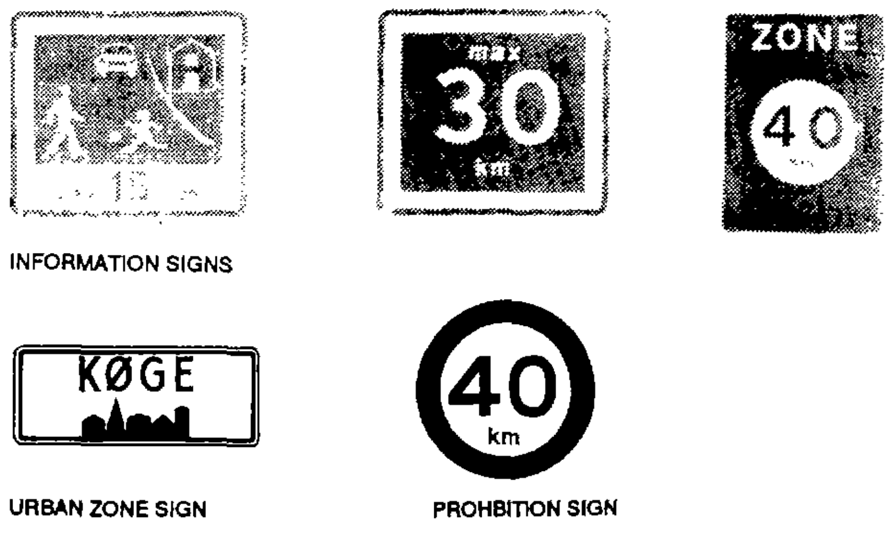
The current system of general speed limits in Denmark is:

- 50 kmh in urban areas
- 80 kmh on highways outside urban areas (and excluding motorways)
- 110 kmh on motorways.

Speed zoning above and below these general limits is used, and speed zones of 40, 60, 70 and 90 kmh were observed. The regulatory signs are the standard red annulus around a black speed limit numeral.

Urban areas are defined by the "urban zone sign" (town name above a schematic skyline; see Figure 3) which advises motorists that an urban area has been entered (and, by implication, that the 50 kmh limit applies; a 50 kmh regulatory sign is not used for this purpose). On roads exiting the urban area, the urban zone is annulled by posting the same sign with a red diagonal line across it. While these signs are generally posted on the boundaries of urban development, their location does not necessarily correspond to a definition of a "built-up area" (ie. presence of houses or street lighting).

Figure 3: Speed signs [from Road Directorate (1991a)*]*



Advisory speed signs are also used ("information signs" in Figure 3), especially in streets designated as "living areas". The signs are white on a dark blue background. The special 15 kmh sign, while only advisory regarding speed, has a regulatory role in that it gives pedestrians priority over all wheeled traffic (including bicycles); however the pedestrians must not unnecessarily impede that traffic. No regulatory speed signs are used in these pedestrian streets, however "the roads must therefore be designed and laid out so as to impede driving at more than 15 kmh, and the street scene must give drivers the impression of being in an area dedicated to pedestrians" (Road Directorate 1991a). Similar principles are applied to the signing and layout of the 30 kmh streets

The *Urban Traffic Areas* road standards (Road Directorate 1991a) define a simple two-level hierarchy of roads:

- traffic roads (designed to serve traffic travelling between local areas), and
- local roads (designed to serve traffic within local areas).

The same standards also define four classes of desired speeds (or target speeds) which may be applied to an individual road:

High	(desired speed 70-80 kmh)
Medium	(desired speed 50-60 kmh)
Low	(desired speed 30-40 kmh)
Very Low	(desired speed 10-20 kmh).

On traffic roads the speed classes High, Medium, or (locally and under special circumstances) Low can be used as a basis for the geometrical design. On local roads the speed classes Medium, Low and Very Low can be used (Road Directorate 1991a).

On local roads (and some traffic roads) in urban areas these desired speeds are achieved mainly through the application of various speed reducing measures. The main types of measures, together with the road class considered applicable, the desired speed they should help achieve, and the traffic level to which each is generally applicable, are shown in Figure 4.

Trials in Denmark to determine the specific design parameters for the humps and staggerings to achieve desired speeds of 30, 40, 50 or 60 kmh, for cars and heavy vehicles, have been reported by Kjemtrup (1988) and Hoj, Herrstedt and Kjemtrup (1989).

4.2 RECENT CHANGES IN URBAN SPEED MANAGEMENT

4.2.1 Impetus for 50 kmh Urban General Limit

A variety of opinions were expressed about the reasons for the implementation of the 50 kmh limit in 1985. Herrstedt believed the change was made for consistency with the urban general limit in other nearby European countries and also because the Danish politicians had a perception that Denmark had a relatively high urban accident rate at the time. She also felt that the change was part of a draft traffic plan (eventually released in 1988) to reduce road deaths and injuries in Denmark by 45% by the year 2000. The plan includes a focus on urban accidents, especially those involving pedestrians and cyclists.

Lund said that the reasons for the change were "somewhat political" and that considerations of energy consumption and pollution issues may also have been involved. He suggested that consistency with the limits in other countries was a post hoc rationalisation of the decision. He declined to comment further (as a civil servant advising the Minister for Justice, the political office principally responsible for regulatory speed limits, this was understandable reaction), but suggested that Professor N. O. Jorgensen, who was a former Research Director of the Danish Council of Road Safety Research, be asked for comments on the issue.

Figure 4: Speed reducing measures [from Road Directorate (1991b)*]*

	Main Type	Road Class		Desired Speed (km/h)			Annual Day Traffic (ADT)	
		Traffic Road	**Local Road**	**≥60**	**50**	**≤40**	**>3000**	**≤3000**
1	**Pre-warnings**	x	x	x	x	x	x	x
2	**Gates**	x	x	x	x	x	x	x
3	**2-lane raised areas**	x	x		x	x	x	x
4	**2-lane humps**	x	x		x	x	x	x
5	**Staggerings**	x	x	x	x	x	x	x
6	**Staggerings with raised area**	x	x		x	x	x	x
7	**2-lane narrowings from road centre**	x	x		x	x	x	x
8	**2-lane narrowings from roadside**	x	x		x	x	x	x
9	**Narrowings to 1 lane**	(x)	x			x		x
10	**Narrowings to 1 lane with raised area**	(x)	x			x		x
11	**Narrowings to 1 lane with humps**	(x)	x			x		x
12	**Staggerings with narrowing to 1 lane**	(x)	x			x		x
13	**Staggerings with narrowing to 1 lane and raised area**	(x)	x			x		x
14	**Staggerings with narrowing to 1 lane and humps**	(x)	x			x		x

(x): To be used only in special cases

Jorgensen confirmed that consistency with other countries was indeed the post hoc political explanation for the decision. However he said that there was a good technical basis for the decision and that he was instrumental in presenting it during the political debate in the early 1980's Apparently a package of general speed limit changes was being considered: an increase in the motorway limit from 100 to 120 kmh as well as a reduction in the urban limit from 60 to 50 kmh. Jorgensen and a colleague (Ole Bach) analysed the consequences of each change in terms of road trauma and its costs. They built on previous evaluations of changes from 60 to 50 kmh in other Nordic countries, and on relationships linking speed changes and road trauma developed by Nilsson in Sweden (see Section 3.2.2). The value of travel time savings was also considered. Jorgensen said that the analysis of the consequences of the increased motorway limit "killed" this component of the package. Apparently the estimated benefits of the urban limit decrease were sufficient to gain political support for this component on its own.

None of the individuals interviewed recalled any substantial opposition to the reduced urban general speed limit. Herrstedt recalled that business car drivers and truck drivers were initially opposed, but this is no longer the case according to her own surveys. Helberg felt that the visible progress being made in changing the road environment of local streets in urban areas at the time helped in gaining general community support for the change. Lund believed that the low level of speed enforcement then operating in urban areas also helped, because the initial behaviour change was relatively small (however speed behaviour has probably changed substantially over the years as more speed reducing measures have been installed to reinforce the urban limit). Jorgensen did not recall more than a little public debate at the time, suggesting that the technical information was persuasive for the community generally.

4.2.2 Other Changes in Urban Speed Management

Before and particularly since the introduction of the 50 kmh urban limit there has been an active program of defining zones in urban areas with Low or Very Low target speed classes. These zones have been mainly on local roads and have employed the full range of speed reducing measures shown in Figure 4. Jorgensen was impressed by the amount of work done in urban streets to indicate to drivers what is considered an "appropriate speed", rather than rely on posted regulatory limits. The zones are marked by the "information " (advisory speed) signs shown in Figure 3.

In addition the traffic roads through urban areas have been treated with speed reducing measures. While the less aggressive measures (see Figure 4) have been typically used, consistent with the Medium desired speed class of these roads, they serve the purpose of physically inhibiting speeds in excess of the 50 kmh limit. Thus they have reinforced the new urban general limit, rather than representing another change in urban speed management. On such treated roads, where the desired speed is 50 kmh, no additional signing is typically used.

Appendix C includes photographs of a variety of speed reducing measures and other treatments used on local and traffic roads in Denmark. A description of notable traffic features shown in each photograph is included in the appendix.

4.2.3 Special Zones and Treatments

Some residential streets, shopping areas and school environs are treated as special zones or precincts, and are given special speed reduction and other traffic management treatments. It was emphasised by Road Directorate staff that considerable attention is also given to making these treatments as beautiful as possible, by the use of architects as well as traffic planners, because it is believed that this affects whether the treatments are correctly used A paper by Bang (1990), architect to the Road Directorate, gives examples of good and bad practice regarding the aesthetics of the treatments.

In residential streets, the 30 kmh (advisory) speed zones are most commonly used. These zones may be indicated by the 30 kmh sign (eg. photos 20 and 21 in Appendix C) or there may be no sign (photos 15 and 16). There is usually a hump (or gateway) at the entrance to indicate an environmental transition, and all or much of the road pavement in the zone may be cobblestoned. In addition, a number of the more severe speed reducing measures are installed at intervals within the zone.

Shopping areas may be defined as pedestrian only zones (especially in the former market areas of old towns) or, if situated along a local road, will commonly be treated in the same way as a 30 kmh (advisory) speed zone street. In addition, there may be special pedestrian facilities such as kerb extensions and very wide pedestrian crossings across the road pavement and the bicycle paths (photo 17). However, if the shopping area is along an urban traffic road (photos 8-12), it will be treated with the less severe speed reducing measures and the emphasis will be on pedestrian and bicycle facilities.

In school environs, it is understood that Danish law requires special treatments of routes to/from school (and of the routes used by children after school). Thus traffic roads near schools are likely to have highly visible pedestrian crossings, with centre refuges and raised cobblestones forming a hump over the crossing. The same crossing also provides a link across the road for bicycle traffic from the bicycle paths on each side (photo 18).

4.3 EVALUATION

A number of evaluation studies have been conducted, principally by the Danish Council of Road Safety Research, of the effects of the 50 kmh urban general speed limit and of the urban speed management treatments implemented during the last decade.

4.3.1 Effects of 50 kmh urban speed limit

Comparing roads in urban areas before and after the change, Engel and Thomsen (1988a) note reductions in average speeds on state and county administered ("major") roads of typically 2 to 5 kmh (from an average speed around 58 kmh), compared with zero to 1 kmh reductions on the locally administered ("minor") roads (where the average speed was already relatively low at 45 kmh).

Engel and Thomsen (1988a,b) examined trends in accidents and their injury consequences, in urban areas of Denmark compared with rural areas, over 39 quarters before 1 October 1985 and 9 quarters after the speed limit decrease on that date. They estimated that the 50 kmh limit was accompanied by the following reductions in risk (all statistically significant):

- accidents: -8.7%
- fatalities: -24.1%
- severely injured: -7.0%
- slightly injured: -10.6%.

They also found that the reductions were somewhat larger (2-3%) on the major urban roads and, while the reductions on the minor roads were still substantial and consistent, none of these were statistically significant (possibly because of the smaller numbers of accidents on these roads).

In a less specific analysis in the same reports, Engel and Thomsen examined step changes in the fatal accident rate (per unit of car travel) on all roads in Denmark from 1972 to 1987. They found that there was a statistically significant 9.7% step reduction in fatal accident risk after 1985. The same analysis also found step reductions of 19.7% and 12.9% after 1974 and 1979, respectively, when other important changes in general speed limits were introduced (see Table 3).

The Danish Council of Road Safety Research also supplied a recent paper by Fridstrom et al (1992) which examined fatal and injury accident trends in the four Nordic countries (including Denmark) on a monthly basis for at least eleven years to 1988. As well as estimating the effects of the Danish speed limit changes in 1979 and 1985, the analysis took into account the effects of road use (measured from traffic counts), weather conditions, the duration of daylight, and the general trend in safety improvements. In this analysis, the apparent effect of the 1985 speed limit change was small and not statistically significant, whereas the 1979 change appeared to have a significant effect on casualty accidents, especially on fatal accidents.

These ambivalent results from the three analyses raise questions about the true effect of the 1985 reduction in the urban general speed limit. The detailed analysis by Engel and Thomsen, which focussed on accidents in urban areas where the change applied, and found expected differential effects on those urban roads where speeds reduced the most, is more likely to be definitive. Their more general analysis of fatal accident rates on all types of road may be misleading, because the analysis by Fridstrom et al suggests that changes in weather conditions and hours of daylight may in fact have produced the observed reduction across the whole of Denmark rather than the 1985 speed limit change

4.3.2 Trial of 40 kmh speed limit in local traffic areas

In 1984, while the urban general speed limit was still 60 kmh, a study of the effects of posting 40 kmh regulatory speed limit signs at the entrances of local traffic areas (within broader urban areas) was made. Engel and Thomsen (1985) examined the effects on speeds and traffic volumes at 21 treated areas, compared with changes in 6 areas where the 60 kmh limit continued to apply. The regulatory signs were not repeated within the treated areas, and apparently no supporting speed reduction measures were installed.

The study found that the 40 kmh regulatory signs were responsible for only a 0.2 kmh reduction in average speeds, and that there were no effects on traffic volumes. The effects on accidents and injuries were not examined.

The results of this trial apparently provided support for the policy that speed reductions on local roads are achieved principally through speed reduction devices (see Figure 4) and that regulatory speed limits, if any, can play only a secondary role.

4.3.3 Effects of local road treatments (target speeds of 15 and 30 kmh)

The Danish Road Traffic Act amendment of 1978 allowed the status of some streets to be changed to "living areas" with priority for pedestrians, the implementation of speed reducing measures, and an advisory speed limit of 15 kmh. However, local authorities also implemented a second type of "living area", without change in the traditional priority for vehicle, less intense use of speed reduction devices, and an advisory speed limit of 30 kmh. An example of the former type of treatment is shown in photo 14 in Appendix C, and photos 13 and 20-21 are examples of the latter. A total of 729 urban streets changed status to living areas between November 1978 and July 1983, and apparently the 30 kmh streets are more frequent (Engel 1990, Engel and Thomsen 1992). Local advice is that the treatments were well received and installation has continued.

Engel and Thomsen examined changes in accident and casualties per kilometre of road in the fifty 15 kmh streets and 679 30 kmh streets, compared with changes in untreated control streets. They found no statistically significant changes in the 15 kmh streets (probably due to the small numbers involved, even though casualties were in fact reduced by 100%) However, in the 30 kmh streets, accident rates were reduced by 24% and casualty rates by 45%; both of these reductions were statistically significant. They also found that in sections of the same streets, adjacent to but outside the 30 kmh zones, accident rates were reduced by 18% and casualty rates by 21%.

At a subset comprising five 15 kmh streets and thirty nine 30 kmh streets (and also 52 control streets), road use was measured so that changes in casualty rates per kilometre travelled could be assessed (presumably the investigators anticipated changes in road travel patterns for various types of road user as a result of the street treatments). Engel and Thomsen found that these casualty rates were reduced by 72% (which was statistically significant) in the treated zones, but that there was a non-significant 96% increase in the rate in adjacent sections of the same streets but outside the treated zones.

Engel and Thomsen also collected data on vehicle speed profiles in the treated streets (and in 13 control streets, where no changes in mean speeds were found). They do not present information on global changes in speed after the 15 and 30 kmh treatments, but instead link speed changes to the various speed reducing devices at the measurement points. This allowed them to develop a model for speed changes in terms of presence of or distance to each device, plus parameters describing the devices (eg. height of hump). Jorgensen considered that this model "concisely" defines the environmental changes which are necessary for a given speed change to achieve a target speed on a section of urban road. The investigators stated that the model explains 61% of the speed changes observed, and that disparities of 5-10 kmh are not uncommon. Nevertheless the model seems to be a useful planning tool for urban speed management treatments

4.3.4 Effects of *Environmentally Adapted Through Roads*

"Environmentally Adapted Through Roads" were trialed in three rural towns in Denmark as an alternative to constructing more expensive bypass roads (Herrstedt 1990, 1992a) The treatment of the main road through each town was based on the *Catalogue of Ideas* (Road Directorate 1981) and aimed to give greater priority to pedestrians, cyclists, and the town environment. This was achieved through a variety of speed reduction devices and other treatments, such as prewarning signs and rumble strips, regulatory speed signs, gateways at the town entrances (formed by changes in road surfaces flanked by trees), road staggerings using lateral and central islands, parking bays, kerb extensions, roundabouts, and side road closures. The target speed in two of the towns was 40 kmh, and 50 kmh in the third Previously the through roads in these towns were subject to the urban general speed limit of 60 kmh.

The investigators found that average speeds were significantly reduced in all three towns (by 8-10 kmh), with even greater reductions on the outskirts of the towns. They also found an increase in travel time for through-traffic drivers, but pedestrians and bicyclists were able to cross the main road more comfortably and more frequently than before. Changes in a number of other social factors were also measured.

Accidents during five years before the treatments were compared with the three years after, but the relatively small numbers have prevented definitive statements on changes in safety. In the two towns with target speeds of 40 kmh, personal injury accidents were halved (from 13) in one and fell from four to zero in the other. There was no change in personal injury accidents in the third town with target speed of 50 kmh (Herrstedt 1990, 1992a). A further analysis of five years accident experience after the treatments has generally confirmed the earlier findings, except that there is now evidence of improved safety in all three towns (Herrstedt 1992b).

4.4 ENFORCEMENT

Speed enforcement using radar guns is currently used, but not often in urban areas according to Herrstedt. Motorways have attracted most of the resources for speed enforcement because of the recent increase in speed limit from 100 to 110 kmh. Jorgensen considered that speed enforcement on urban traffic roads could be improved, but suggested that the urban local roads were essentially self-enforcing because of the speed reducing measures which had been installed widely. Police strategies and tactics in this area are currently being discussed.

Speed cameras are not in general use, but a pilot study in being considered to trial them on motorways. Lund advised that these would be installed at fixed locations, in a visible box with a flashlight, and warning signs would be posted in advance.

Lund also described a current trial of dynamic speed feedback signs in two Danish counties. Developed by Golden River, the sign displays the actual speed of a passing car to its driver. An earlier trial of a sign which flashed if a driver was travelling too fast approaching a bend showed that it was effective in reducing their speeds through the bend, especially in wet weather (Larsen et al 1990). Jorgensen described another trial of two dynamic feedback signs installed at the entrances of the four-lane undersea tunnel on the E47 highway between Falster and Lolland. The approach roads are only two-lane and there were severe accidents on the transition sections. A before-and-after study of speeds in the tunnel was carried out by the Danish Road Directorate and showed that average speed decreased by 3-4 kmh at the beginning of the tunnel, but in the middle and at the other end the average speed reached the same level as on the highway before the tunnel (Nielsen 1992).

4.5 GENERAL ASSESSMENT

Each of the groups interviewed were asked for their general views on the Danish urban speed management system, whether it is working well and what improvements where seen as needed.

Herrstedt considered that the current system is working well. The *Urban Traffic Areas* road standards provide a fine planning tool for speed management. She believed that the program of environmental change needed to continue in order to achieve long term changes in urban speed behaviour. There is still a need for enforcement aimed at excessive speeders.

Helberg and Lund generally agreed with Herrstedt. They saw a need to devote more attention to the urban speed problem in order to achieve target speeds of 30 or 40 kmh. While physical treatments would be effective and acceptable in some streets, they supported higher levels of enforcement also. While the road safety plan to the year 2000 called for a doubling of police resources, there were political and local government debates about who pays and who benefits which may impede future action.

Jorgensen generally concurred with the other groups but, while agreeing that the biggest problems are with pedestrian and bicyclist injuries, these were not just a speeding issue. He saw a greater need to introduce better cyclist regulations at intersections and roundabouts (from my observations as just a passenger in Danish cars, I agree). He suggested that while the 30 kmh (advisory) speed zones are already used liberally by local authorities, more could be installed. He commented that the 15 kmh zones required much more environmental change to support the very low target speed and hence were expensive, unfortunately; however Engel and Thomsen's (1990, 1992) model provide a "concise" planning tool for installing the speed reducing measures cost-effectively.

4.6 OVERVIEW OF DANISH RESEARCH AND ISSUES

The reduction in the urban general speed limit in Denmark from 60 kmh to 50 kmh in 1985 did not occur in a vacuum. There was already a realisation that urban speeds could not be reduced by speed limits alone. Ideas and standards for various speed reducing measures had already been developed, legislation existed to allow their installation on local roads, and a progressive program of treatment of both local and traffic roads had commenced.

There is evidence that the reduction in the urban limit was accompanied by a reduction in accidents and injuries (especially fatalities) in urban areas, especially on the urban roads where speeds reduced the most. There is also evidence that the speed reduction measures installed in the 30 kmh (advisory) speed zones on urban local roads are effective in reducing accidents and injuries. Such measures installed on main roads through rural towns also appear to be effective.

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APPENDIX A

SPEED AND SAFETY:

RESEARCH RESULTS FROM THE NORDIC COUNTRIES

SWEDISH SECTION

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1.SPEED MEASUREMENTS AND SPEED-FLOW ANALYSIS.

ONE IMPORTANT QUESTION IN RELATION TO SPEEDS IS THE RELATION BETWEEN SPEED AND TRAFFIC FLOW.

One experience in Sweden was that the speed-flow relations presented in the USA Highway Capacity Manual in the early seventies did not correspond to the situation in Sweden.

One explanation for that can be that in relation to traffic flow the road standard is higher on average in Sweden, which means that the experience of capacity problem was limited in Sweden. The results from Sweden showed that the speed levels were more or less independent of traffic flow even during periods with, in relation to Swedish conditions, high flows.

In "Calculations of the relations between speed and traffic flow" by Björn Kolsrud, VTI Report 97, 1977, the author started from the statement that the speed adjustments of the drivers are primarily influenced by the density of traffic and that the adjustments have two componets - the basic speed and the congestion speed. The basic speed varies between different types of vehicles while the congestion speed is the same.

The validation of the model was very successful and performed even for Finnish conditions. The model was however not validated for high flows at that time. Later on an additional study was made at high flow conditions and the results were in agreement with the model. One weak point of the studies were the limited number of speed measurements.

At the end of the seventies systematic speed measurements were introduced on the rural roads in Sweden by VTI. All speed measurements cover a 24-hour period.

For the years 1979 to 1982 92 points were investigated, which resulted in 353 24-hour periods of speed measurements for individual vehicles. The sample covers different roads and different speed limits.

In VTI, Meddelande 415, 1984, a model is presented which shows the estimated/emperical speed devolopment which and without speed limits. The data was also used to investigate the yearly speed trend for passenger cars and the influence on speed of the traffic flow (passenger cars and lorries) and of the lorry flow (VTI, Meddelande 390, 1984).

A regression analysis gives no significant coefficients but a interesting fact was that the non-significant coefficients in most cases were positive. This was expected for the speed trend, but not for the influence of the lorry flow. The total flow variable showed a very limited effect on the speed of passenger cars from -1 km/h per 1000 vehicles to +0.5 km/h per 1000 vehicles!

One conclusion from the above is that factors, which are supposed to reduce the speed can have the opposite effect.

One explaination is that the traffic flow both indirectly and directly influence the drivers speed level. Increasing speeds at higher traffic flows means that the drivers increase their basic speeds more than the direct effect of the traffic flow decrease the speeds. The results above are from rural roads and the traffic flow is the 24-hour value.

Later preliminary results from urban areas, based on hourly traffic flows on individual streets, show that there exist a statistically significant decreasing effect on speed with increasing traffic flow.

This influence is to a great extent depending on different basic speeds during the 24-hour period. If the 24-hour period is divided into smaller periods 0-6, 6-9, 9-15, 15-18, 18-24, the first and the last period show a stronger relationship and have on average lower hourly flows and higher speeds. The three other periods show an influence which is significant and between -0.3 and -0.5 km/h per 100 vehicles. A simple conclusion is that if we regard the intercept in a regression model as the basic speed, this basic speed increases with incresed influence of increased flow.

The speed limit is also important. At low flow periods, less than 100 vehicle per hour (normally during night time), the existence of additional vehicles on the street has a strong speed-reducing effect, which is not a real flow effect but more a social effekt or an afraidness of police enforcement as speeds are normally much higher than the speed limit. On the other hand the speed limit itself can contribute to increase the speeds at high traffic flows. The drivers try at least to drive at the level of the speed level.

One conclusion concerning speed development over time is that there exists a speed trend of increasing speeds due to faster vehicles but the increasing traffic flow has a very little effect. Increasing traffic beetween years can result in higher speeds. The speed limit system becomes more and more important as it tends to regulate both too high speeds but also too low speeds, which means that the variation in speeds decreases with increasing traffic flow.

In relation to other speed-changing factors, road standard, speed limit, winter road conditions, traffic regulation measures in intersections etc. the traffic flow itself is of a little importance for the speeds with the exception of situations when the road network is overloaded.

2.EFFECS ON ACCIDENTS AND SPEEDS OF DIFFERENT SPEED LIMITS.

During the years 1968-1972 a lot of trials with different speed limits were performed in Sweden for all rural roads. An important background for this was the change to right hand traffic in sepember 1967. In order to control the safety situation after the change speed limits were used. It began in rural areas with 60 km/h the first days and 70 km/h for the the first months and then 80 km/h . In May 1968 the first trial with a differentiated speed limit system was started (130 km/h on motorways and 110 or 90 on two-lane roads).

The trial was stopped after less than 2 months and the speed limits of 110 km/h on motorways and 90 km/h on two-lane roads were introduced during the summer. In september the next trial with differentiate speed limits started but with a reduced number of roads with 110 km/h. This trial continued to April 1970 when 110 km/h on motorways and 90 km/h on two-lane roads were introduced again. In June 1971 the basic speed limit of 70 km/h was introduced on rural roads. Two-lane roads of good or very good standard were regarded as exceptions and recived the speed limits of 90 km/h or 110 km/h. The speed limit on motorways was unchanged, 110 km/h.

This latter system has been in force until 1989, with the exception of June to October 1979, when due to energy saving reasons the speed limit of 110 km/h was replaced with 90 km/h. The same occured in the summer 1989 from traffic safety reasons. From the end of August 1989 the speed limit on motorways close to high-density populated areas is 90 km/h due to environmenal reasons.

In relation to the above changes of the speed limits on rural roads investigations have been made in order to estimate the safety and speed effects. In the the first analysis the changes in speed and safety were treated separate from each other but further on it was realized that the safety effect had a strong relationship with the change in speeds.

In table 1 the accident rate, number of police reported accidents per million vehiclekilometer, is presented for the different changes of speed limits on rural roads. Most of the experiments (E) also have controls (C) where the speed limit was unchanged.

Table 1: The results from different changes of speed limits on rural roads in Sweden 1968-1972.

Change in Speed Limit	Accident rate Before	After	Change %	Change in Injury Accidents %	Number of Fatalities Before-After
No SL - 90	0.51	0.43	-16	-10	63-44
No SL - 110	0.52	0.50	- 4	+10	40-44
90 - 110 (E)	0.32	0.46	+44	+47	8-22
90 - 90 (C)	0.37	0.41	+11	- 1	14-12
110 - 90 (E)	0.45	0.32	-30	-25	14-11
90 - 90 (C)	0.34	0.35	+ 3	+ 7	8-10
90 - 70 (E)	0.69	0.54	-22	-24	80-46
90 - 90 (C)	0.58	0.58	0	+ 6	61-60
90 - 70	-	-	-	-11	139-122
90 - 110(E)	0.36	0.38	+ 6	+ 7	16-13
90 - 90(C)	-	-	-(4-5)	-	
90 - 110(E)	0.38	0.54	+42	+47	7-14
90 - 90(C)	0.57	0.52	- 9	- 5	19-14
130 - 110	0.58	0.40	-31	-17	32-28

If we summarize the number of fatalities in the periods with the higher speed limit and compare with the periods with the lower speed limit the number of fatalities is 30 % more on the experimental roads but unchanged on the control roads. On the average the above corresponds to situations where the speeds were changed with 6-8 km/h due to a change of the speed limit with 20 km/h.

The corresponding calculations for personal injury accidents was an increase with 18 %.

These findings resulted in different trials to summarize the relationship between speed changes and traffic safety.

It was found that the change in injury accident rate was very close to the square of the relative change in median speed or mean speed. This corresponds to psysics and kinetic energy ($E = m \cdot v^2$). More interesting was the change in fatality rate which was very close to the fourth potence of the relative change in median speed or mean speed.

The later can be interpretated as two effects, one on the number of injury accident rate and one on the consequence on the severity of the injuries or the probability of being killed if the road user is injured - both effects proportional to the square of the relative change in speed level.

In 1979, from June to October, the speed limit of 110 km/h was replaced with 90 km/h in Sweden. The evaluation confirmed the above mentioned modell and at the same time it was also possible to divide the accidents into fatality accidents, accidents with severe injury or fatality and injury accidents. The mean speed decreased with about 10 km/h and the number of fatality accidents decreased with 52%, the accidents with severe injury or fatality decreased with 34 % and the total number of injury accidents decreased with 24 %. Even if the estimation of the effect on fatality accident are uncertain the pattern gives a clear evidence that a speed reduction results in reduced injury accident risk and reduced injury consequences.

During the 1970-ies the corresponding results were found in Finland, Denmark and Norway. Most interesting are the results from Finland, which are presented in "The speed limit experiments on public roads in Finland" by Markku Salusjärvi, Technical research centre of Finland, Publication 7/1981.

3.TRAFFIC SAFETY SITUATION WITH REGARD TO SPEED LIMIT AND SPEEDS.

In order to analyse the traffic safety situation measurements are needed for comparison of different parts of the road and street network during different periods of time. the road and street net-work during different time periods.

The most common measure is the number of accidents reported by the police related to the vehicle milage (the number of accidents per million vehiclekilometer = accident rate). In this cas the accident population ought to be limited to accident with injured - injury accidents. A more accurate measure when we want to analyse the relation the relation between speed and safety is the number of injured per million vehiclekilometers - injyry rate. This last measurement takes at the same time into account both the accident rate and the severity of accidents.

$$\frac{\text{Number of accidents}}{\text{Million vehiclekm.}} = \frac{\text{Number of injured}}{\text{Number of accidents}} \times \frac{\text{Number of injured}}{\text{Million vehiclekm.}}$$

Several research projects have been aimed at describing the traffic safety situation due to the existing speed limit and road and traffic factors for road authorities. This can be illustrated with the following table. The accident rate is based on all police reported accidents but transformed to "average" accidents. This means that different accident types on roads with different speed limits are related to to the average accident concerning the severity of injuries.

Table. Expected accident rate for rural roads. All accidents with regard to road width, sight conditions and speed limit.

Road width (m)	Speed Limit km/h	Proportion of road length with sight distance > 300m 70%	40%	20%	20%
4	70	1,05	1,10	1,20	1,40
5	70	1,01	1,05	1,12	1,30
6	70	0,98	1,02	1,09	1,20
	90	1,00	1,03	1,08	1,16
6.5	70	0,96	1,00	1,05	1,15
	90	0,94	0,97	1,02	1,10
	110	0,70			
7	70	0,94	0,97	1,02	1,10
	90	0,84	0,87	0,92	0,99
	110	0,66			
8	70	0,92	0,95	0,99	1,05
	90	0,72	0,75	0,80	0,87
	110	0,64			
9	70	0,90	0,93	0,98	
	90	0,70	0,73	0,78	
	110	0,63			
13	90	0,61	0,64		
	110	0,62			
ML	90, 110	0,55			
4F	70, 90	0,55			
MV	90, 110	0,37			

The results above refer to the road system. Another way is to refer to road users or vehicles. In the report "Speeds, accident rates and personal injury consequences for different road types", VTI, Report 277, 1984, an attempt is made to compare the safety situation for car occupants on different road types with different speed limits. Therefore the accident population was limited to accidents only involving passenger cars and in which at least one car occupant was injured. The accident rate was the number of cars involved in these accidents per million vehicle kilometer. In the analysis speed limit was replaced with average speed.

The following results were obtained for 1977-1981

- The higher the road standard is the higher are the speeds
- The higher the road standard is the lower are the accident rates for accidents with personal injuries in passenger cars
- The higher the speeds are the higher is the number of injured persons per accident car
- The higher the speeds are the higher are the injury consequences for injured car occupants
- The number of injured persons in cars involved in accidents and the proportion of seriously injured or killed of all persons injured is lower on motorways in spite of the high speeds. This is due to the fact that head-on collisions and accidents in intersections have been eliminated through central reserves and grade-separated junctions

The results above are also summarized in the following table

Type of road	Average for speed passenger cars	Accident rate for passenger cars*	Total number of injured persons per accident car	Number of killed per accident car	Number of seriously injured per accident car
MV/110	108	0.11	1.17	0.063	0.294
MV/90.	100	0.17	1.17	0.066	0.316
ML/110	102	0.14	1.31	0.180	0.390
110	100	0.27	1.25	0.089	0.441
90	90	0.27	1.18	0.074	0.378
70	80	0.37	1.00	0.046	0.237

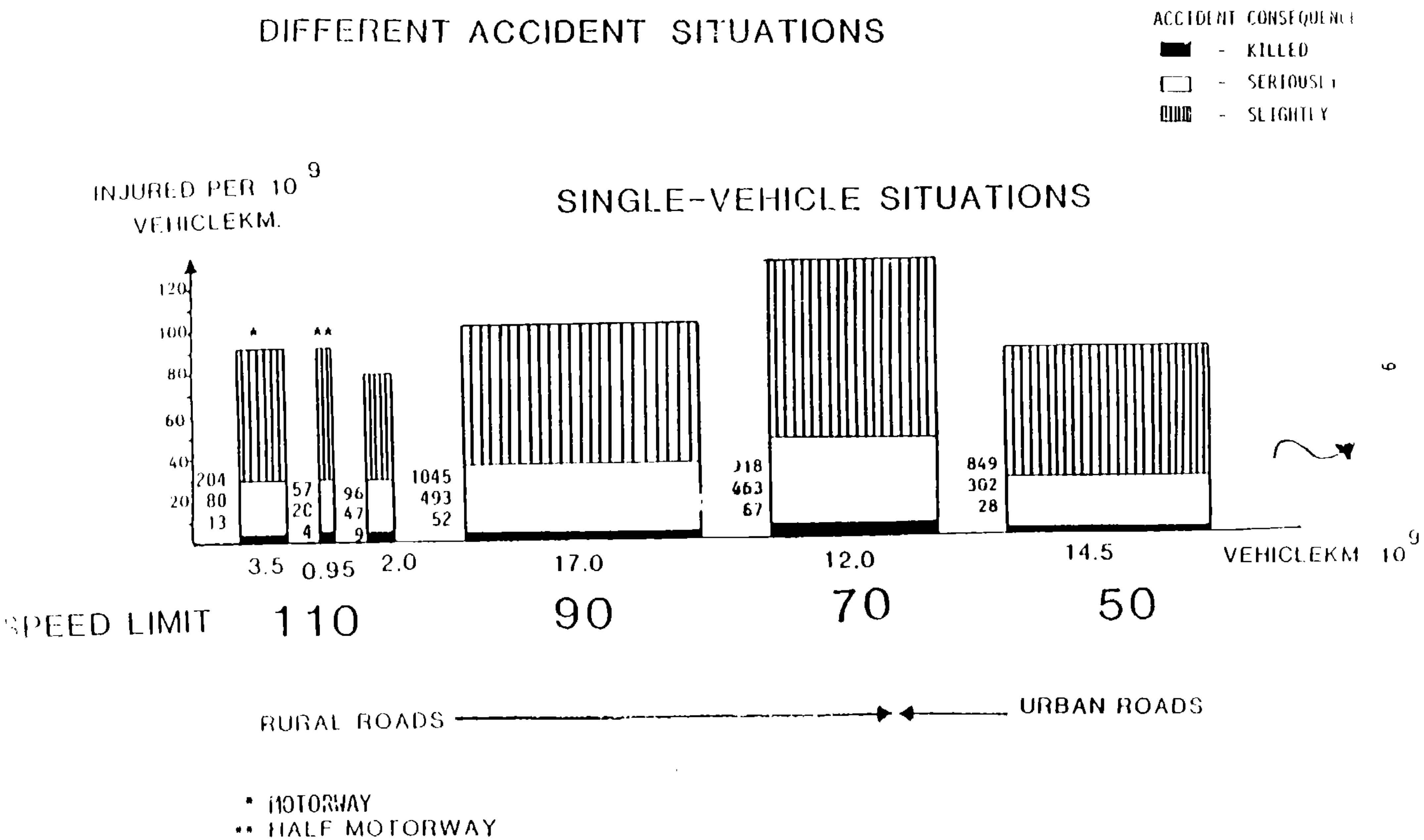
* Number of accidents with personal injuries in passenger cars per million vehicle kilometer.

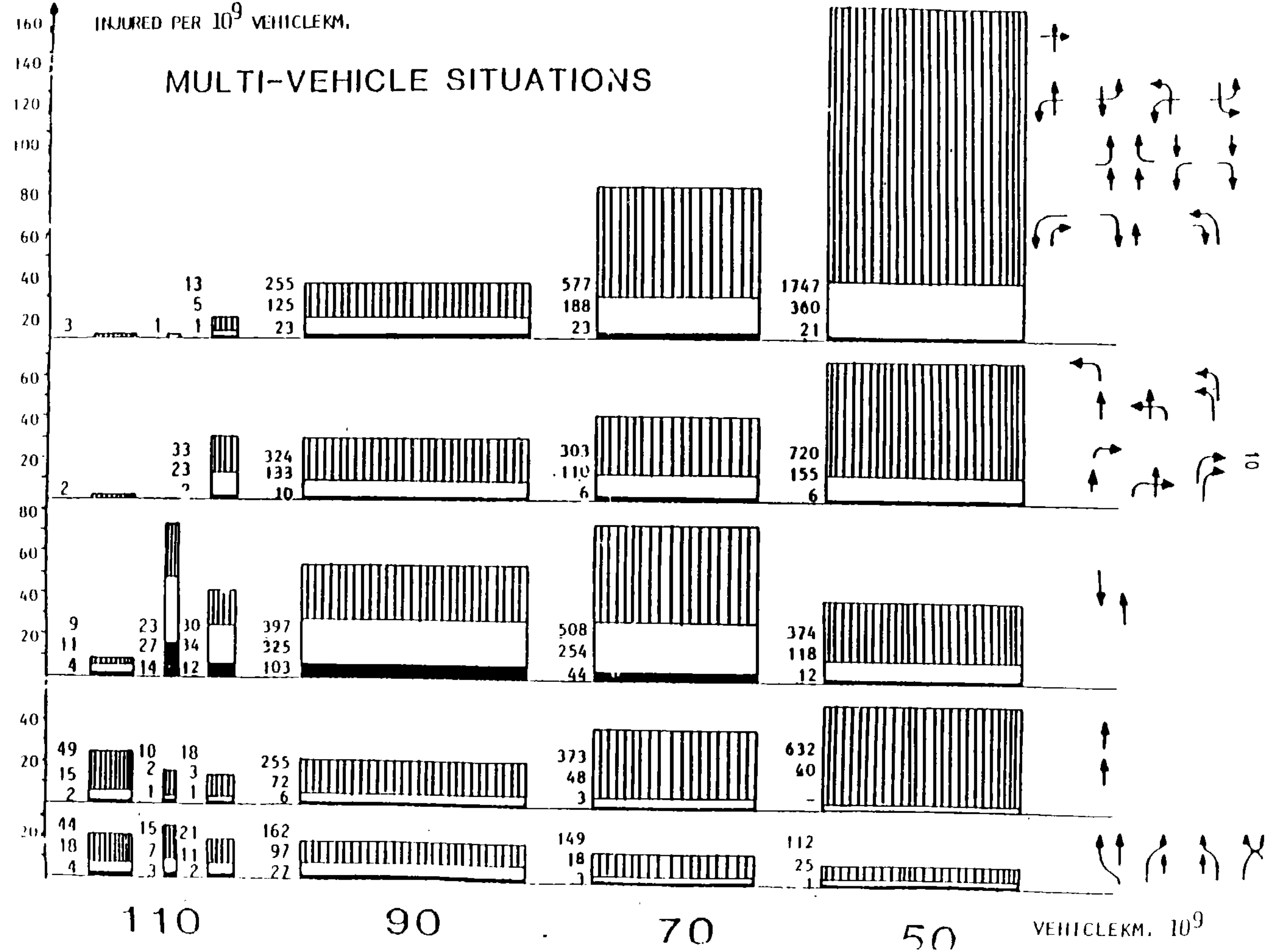
Beside the result presented above it was also confirmed that speed had a greater effect on fatalities and severely injured than on the total number of injured. Still more interesting was that the earlier presented results of the change in fatal, severe injury and all injury accidents due to changes in average speed also was valid for roads with different speed levels.

In "Accident statistics, accident risk and consequences and accident situations", VTI NOTAT T12, 1987, the injury rate sitation is described for the whole Sweden with regard to speed limit, road standard and vehicle milage, environment and accident types.

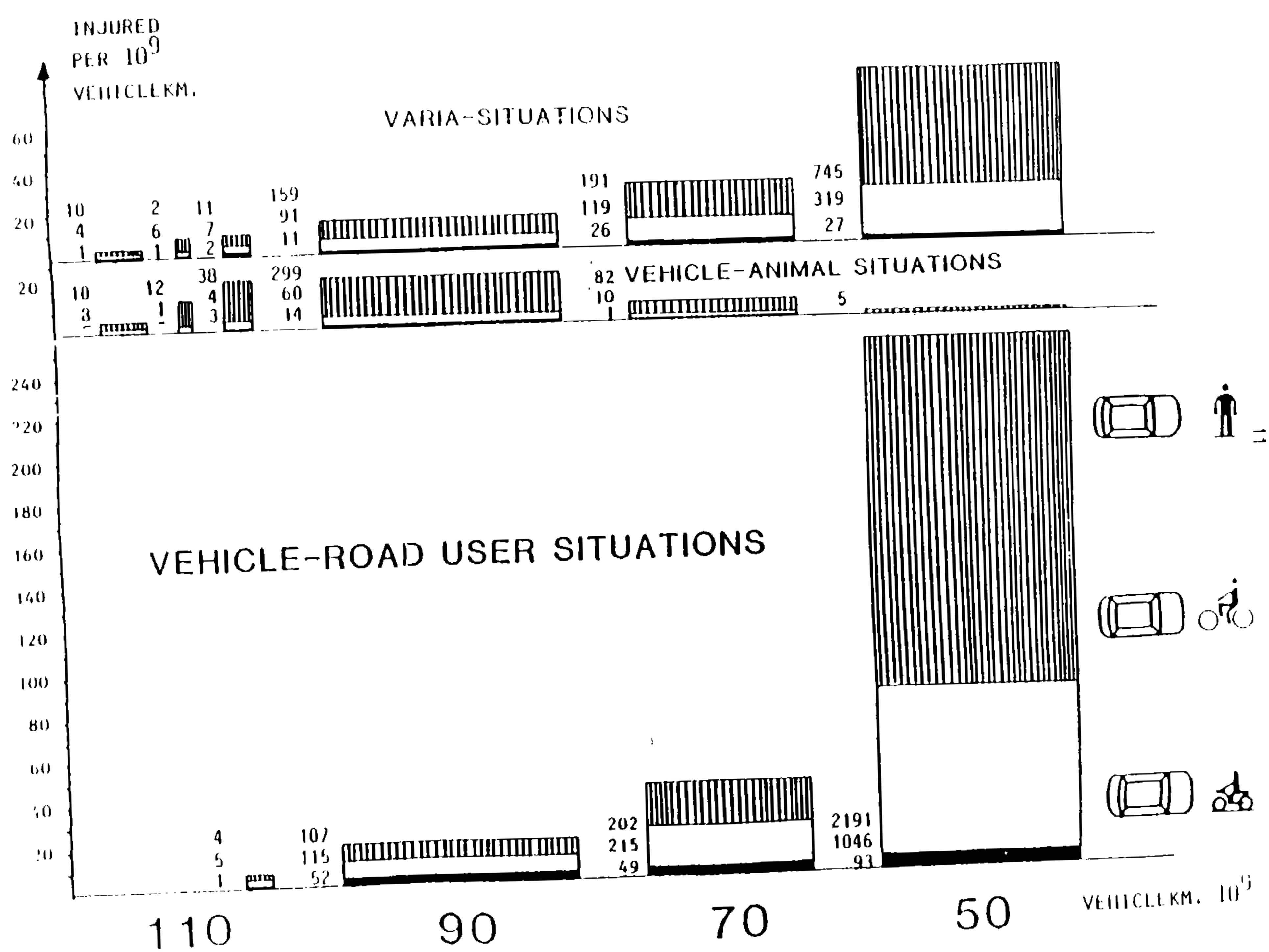
POLICE-REPORTED INJURED IN SWEDEN 1985 IN

DIFFERENT ACCIDENT SITUATIONS





INJURED PER 10^9 VEHICLEKM.
MULTI-VEHICLE SITUATIONS
110
90
70
50
VEHICLEKM. 10^9


INJURED PER 10^9 VEHICLEKM.
VARIA-SITUATIONS
VEHICLE-ANIMAL SITUATIONS
VEHICLE-ROAD USER SITUATIONS
VEHICLEKM. 10^9
110
90
70
50
10
4
1
2
6
1
11
7
2
159
91
11
191
119
26
745
319
27
10
3
12
1
38
4
3
299
60
14
82
10
1
5
4
5
1
107
115
52
202
215
49
2191
1046
93

4.FACTORS BEHIND THE DRIVERS CHOICE OF SPEED LEVELS.

An investigation in Sweden there a random sample of drivers were asked about their normal speed level on a normal road with the speed limit 90 km/h showed that 38% drive with a maximum speed of 90 km/h. 46% drive normally with a speed between 90 and 100 km/h and 15% over 100km/h.

The above results correspond to emperical speed measurements.

In order to find out the factors for the choice of speed levvel and the relativ importance of these factors between the three groups a lot of factors were presented.

o Speed-limit acceptance
o The risk of accidents
o The feeling of danger
o Afraid of the police
o Energy savings reason
o Difficult to overtake
o Emmisions
o General responsibility
o Sanctions at speed violation
o Noice
o Conformity in traffic

These factors were related to the question: WHY NOT DRIVING FASTER?

The factors above are given in the order of importance for the low speed level group. The order is about the same for the other two groups but the importance is less the higher the speed level.

There are three factors which differ very much between the groups. They are "Speed limit acceptance", "Risk of accidents" and "Emmisions" and one factor of the same importance is "Afraid of the police".

Given the opposite question: WHY NOT DRIVING SLOWER? the drivers were presented to the following factors.

o Impede the traffic
o Acceptance of speed limit
o Risk of accidents
o Conformity of traffic
o Stress
o Dullness
o Loss of time

The order above mirrors the importance for the slow driving group. Not to impede traffic is the most important factor for all three groups and of the same magnitude!

The big difference between the groups is the "Dullness" factor.

The strong importance of not to impede traffic even among the fast drivers is alarming and can be interpretated as a behaviour that gradually increases speeds then traffic increase.

An evidence of that is that increasing traffic has very little influence on the speed level on high standard roads. If we combine the factors "Dullness" and "Not to impede traffic" for the fast drivers we can imagine the race track sitution for these drivers. (VTI Annual Report 1987/88, Attitudes to the trend in speeds.)

In "The speed of cars as a function of variables relating to journey, the vehicle and the car owner", Göran K. Nilsson, VTI Meddelande 589, 1989, speed differences are estimated due to journey, vehicle and car driver. The results show that different purpose of journey give a maximum difference in speed of 5 km/h. Different combinations of covered and remaining distance give a maximum difference of 11 km/h. Model and age of vehicles 9 km/h, age of owner and driving licence 8 km/h. Each additional meter of the paved width of the road increases the speed with 0.4 km/h. These result refers to cars owned by men and speeds on roads with the speed limit of 90 km/h.

The above results indicate very strongly that changes in the above distribution of variabels in traffic can result in changes of the average speed level over time.

One of the main problem behind the above results is that current cars have a speed capability much higher than the existing maximum speed limit. With the exception of some motorways in West Germany the maximum speed limit on motorways is in the range of 90 to 130 km/h. On normal two-lane rural roads the maximum speed limit is in the range of 80 to 110 km/h. The development of cars concerning comfort and speed capability have resulted in an increasing gap between the level of the speed limits and the possibilities to drive faster than the highest speed limits. During the sixties and the seventies it was still a correspondence between the highest speed limits and the average speed capability of the car fleet. However the new cars introduced in Europe during the late seventies and in the eighties have however change this situation.

The above can be described with the speed capability of Volvo cars during the post-war period ("Road safety technology" by Stig Nordqvist, Swedish National Board for Technical Development, Information No 667,1988).

5. SPEED ENFORCEMENT

One way to summarize the findings of the effect of traffic enforcement is through the following statements:

- o Drivers learn very fast about enforcement activities
  - -where
  - -when
  - -which behaviour
  - -levels of tolerance
- o Personal experiences are more important than experience through others or through mass media.
- o Enforcement is most effective when
  - -it is visible
  - -there is a high rate of commuters
  - -it is massive
- o High probability of detection is more important than severe sanctions.

The above is of course also valid for speed enforcement. It is difficult to compare the differences between the Nordic countries. The sanctions for speed violation is very high in Norway and the probability of detection is highest in Finland compared to the other countries. Compared with Sweden the probability of detection is 3 to 4 times higher. In the figur below the proportion of drivers not driving faster than the speed limit is presented for different speed limits on two-lane roads in the Nordic countries. The difference between Finland/Norway and Sweden is obvious. To some extent the results are depend on differences in the speed limit levels and the road standard.

On motorways there is little difference between Denmark, Sweden and Norway if we take the differences in speed limit into consideration.

Since the middle of the eighties several experiments have been carried out in Sweden in order to increase the influence on speeds through different strategies concerning the use of radar equipment combined with information activities.

The information covers advertising in local papers and road signs in local urban areas. The result of advertising is more or less that in the beginning the papers also have articles about the enforcement, which makes almost all readers aware of the enforcement. This is however just the case for a couple of weeks. Road signs, with the message of that speed enforcement is going on in an urban area, have not shown any additional effects on speeds compared to the effect of advertising and the speed checks. The speed on spots where speed enforcement was performed regularly, every second week, were gradually decreasing during the experimental period. On the other hand speed measurements before and after the experimental period on streets not used for speed checks show no effect on speed behaviour, when compared with speed measurements in urban areas chosen as control areas.

The above experiment was performed during one year (1986), in six cities, of which two were the experimental areas and the other four were used as control areas. The cities were situated in two different counties, three in each county. During the analysis of the experiment some confusing results appeared. The average speed level was different in the two counties but the proportion of drivers reported by the police of all controled drivers was the same.

One of the possible explanations was quite clear when it was found that the level of tolerance was not the same. The tolerance level was on average 5 km/h higher in the county with higher speeds.

To test this it was decided to continue the experiment during the next year, but the advertising was deleted. In the speed check program the police lowered the tolerance level with 3 km/h in the county with the lowest tolerance level and with 5 km/h in the other county in the experiment areas (The city of Jönköping and the city of Halmstad).In the other four cities (Nässjö, Falkenberg, Husqvarna and Varberg) the tolerance level was unchanged. During the year a national speed campaign was going on and in the middle of the experimental period the speed violation fines were increased with SEK 200. (Speeds as a function of tolerance level, penalties and surveillance intensity, Gunnar Andersson, VTI Report 337, 1989).

After the experimental period a road side interview was performed on the speed check points. From the interviews it was found that the knowledge of the change of the fines was very limited among the drivers.

However the speed measurements after the experimental period on streets outside the speed check program compared with the corresponding speed measurements one year earlier were however interesting. The result is presented in the table below, there the change in percent of drivers exceeding the speed limit and drivers exceeding the speed limit +9 km/h in the six urban areas are shown.

Urban area	Change in the number drivers over SL %	Change in the number of drivers over SL+9 km/h %
Experiment areas		
Jönköping	-8.7	-11.7
Halmstad	-7.7	-11.4
Control areas		
Nässjö	+10.0	+12.8
Falkenberg	+3.0	-1.6
Husqvarna	+3.4	-0.2
Varberg	+7.8	+1.9

The average speed was decreasing with about 1 km/h in the experiment areas and was increasing with about 0.5 km/h in the control areas. High speeds were effected more than the average speed in the experiment areas and was unchanged in the control areas.

Lowering the tolerance levels had the effect that of the drivers driving faster than the speed limit the proportion of drivers under risk of being detected for speed violation increased from 37% to 53% in Jönköping and from 12% to 30% in Halmstad. One interpretation of this is that the use of the lower tolerance level change the risk of being detected corresponding to a twice or three times increased use of speed checks using the earlier tolerance level.

The road side interview after the experiment also showed that the drivers perception of the tolerance levels used in the two counties was different. On the other hand the majority of drivers believe that the tolerance are much lower than in reality, which means that they overestimate the risk of being detected at speeds over the speed limit.

Compared with the speed behaviour this is confusing but even if the drivers overestimate the risk of being detected in a speed check their opinion of the existence of speed checks seems realistic. A rough calculation of the probabilty of being detected if the driver drives according to the speed distibution of all drivers and have an average driving distance during a year is once in 40 years in Sweden. On the other hand this means that less than 1 of 40 drivers every year is detected, as some drivers are detected more than once during one year.

Experience from Sweden shows that to make the driver change his speed behavior as an effect of increasing enforcement, the existence of the enforcement must increase 3 to 5 times compared with the existing level in rural areas.

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APPENDIX B

RELATIONSHIPS BETWEEN CHANGES IN MEDIAN OR MEAN SPEED AND CHANGES IN FATALITIES, SEVERE INJURIES AND OTHER INJURIES

Väg-och Trafik-Institutet

1

CHANGE IN NUMBER OF FATALITIES WHEN MEDIAN OR MEAN SPEED IS CHANGE FROM V_0 TO V_1

$$\text{NUMBER OF FATALITIES } (V_1) = \left[\frac{V_1}{V_0}\right]^4 \left[\text{NUMBER OF FATALITY ACCIDENTS } (V_0)\right] + \left[\frac{V_1}{V_0}\right]^8 \left[\text{NUMBER OF FATALITIES } (V_0) - \text{NUMBER OF FATALITY ACCIDENTS } (V_0)\right]$$

Väg- och Trafik-Institutet

CHANGE IN NUMBER OF FATALITIES AND SEVERE INJURED WHEN MEDIUM OR MEAN SPEED CHANGE FROM V_0 TO V_1

$$\begin{array}{c}\text{NUMBER OF}\\ \text{FATALITIES AND}\\ \text{SEVERE INJURED}\\ (V_1)\end{array} = \left[\frac{V_1}{V_0}\right]^3 \left[\begin{array}{c}\text{NUMBER OF FATALITY}\\ \text{AND SEVERE INJURY}\\ \text{ACCIDENTS } (V_0)\end{array}\right] +$$

$$\left[\frac{V_1}{V_0}\right]^6 \left[\begin{array}{c}\text{NUMBER OF}\\ \text{FATALITIES AND}\\ \text{SEVERE INJURED}\end{array} - \begin{array}{c}\text{NUMBER OF FATALITY}\\ \text{AND SEVERE INJURY}\\ \text{ACCIDENTS } (V_0)\end{array}\right]$$

Väg- och Trafik-Institutet

CHANGE IN NUMBER OF INJURED WHEN MEDIAN OR MEAN SPEED IS CHANGED FROM V_0 TO V_1

$$\text{NUMBER OF INJURED } (V_1) = \left[\frac{V_1}{V_0}\right]^2 \left[\text{NUMBER OF INJ. ACCIDENTS } (V_0)\right] + \left[\frac{V_1}{V_0}\right]^4 \left[\text{NUMBER OF INJURED } (V_0) - \text{NUMBER OF INJ. ACCIDENTS } (V_0)\right]$$

APPENDIX C

SPEED MANAGEMENT TREATMENTS
IN LINKÖPING, SWEDEN
AND
IN COPENHAGEN AND NORTH ZEALAND, DENMARK

Photo 1: **Djurgardsgatan, Linköping** (Inner road, 50 km/h speed limit)
Note: Narrowed pavement (2 traffic lanes). Median between motor and bicycle traffic (with tree planting). Narrower visual appearance.

Photo 2: **Drottninggatan, Linköping (from west).**
(Inner road, 50 km/h speed limit)
Note: Narrowed pavement (2 traffic lanes). Parking ban. Gateway impression at narrowing by use of trees and kerbside bollards. Bicycle path entry at narrowing.

Photo 3: **Drottninggatan (from east).** (Inner road, 50 km/h speed limit)
Note: Narrowed pavement (2 traffic lanes). Tree planting on one side to give narrow visual appearance (both sides were desired, but could not be accommodated).

Photo 4: **Drottninggatan (at T intersection).** (Inner road, 50 km/h speed limit)
Note: Cobble stones for motor traffic. Contrasting paving bricks on pedestrian crossings. Different paving bricks for bicycle paths.

Photo 5: **Linköping.** (Outer ring road, 70 km/h speed limit)
Note: Four traffic lanes. Parking ban. Wide visual appearance.

Photo 6: **Linköping (residential area).** (Bus only road)
Note: Closed to private motor vehicles. Provides bus route behind and around residential street system.

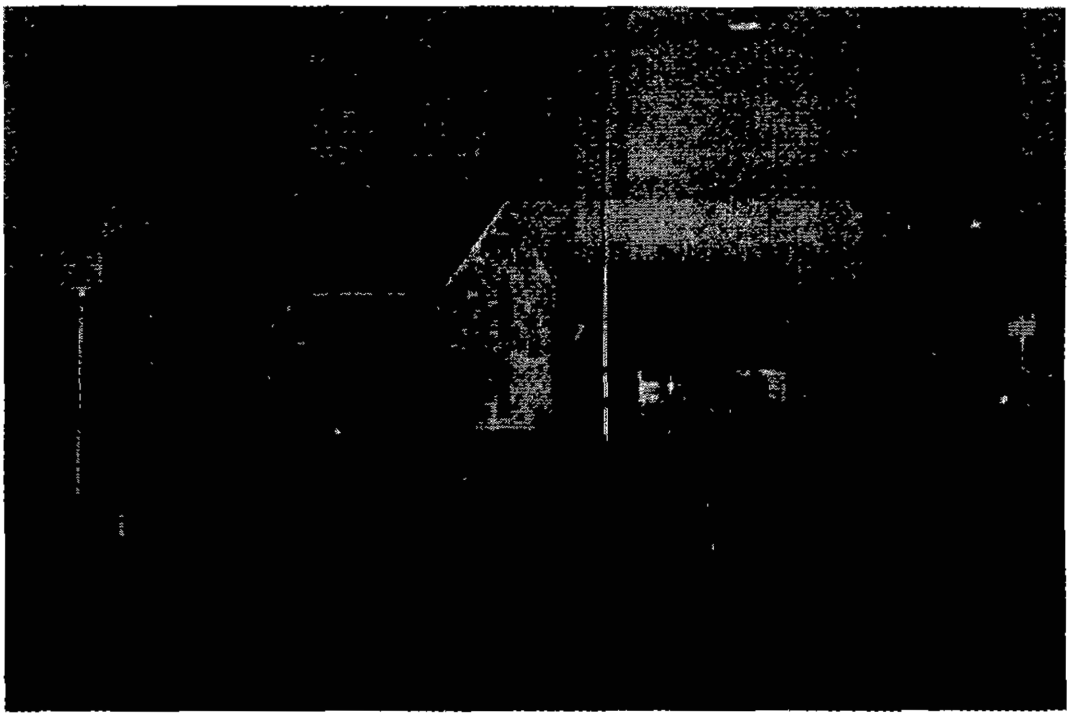
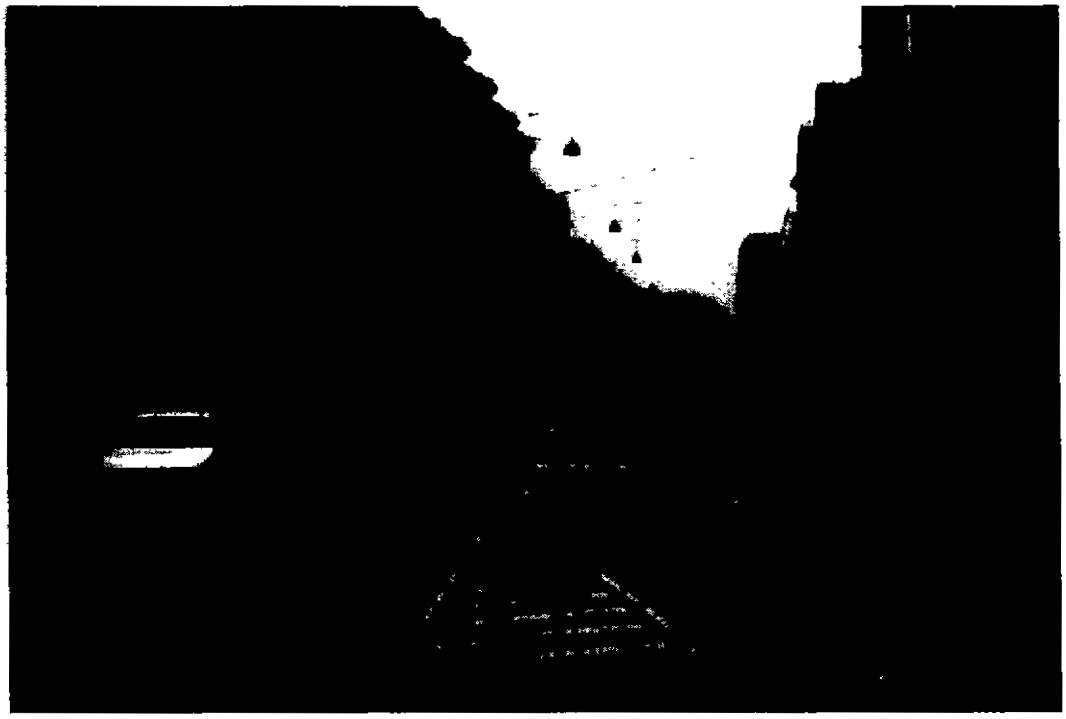


Photo 7: **Linköping (residential area).** (Bus stop, 50 km/h speed limit)
Note: One traffic lane. Bus stops other traffic in both directions when stationary at bus stop. Distinctive striped signing.



Photos
8 & 9: **Strandvejen, Hellerup (suburb of Copenhagen).**
(Traffic road, (through shopping area), 50 km/h speed limit)
Note: Narrowed pavement (2 traffic lanes). Parking bays and kerbside turning lanes. Wide central median/pedestrian refuge. Centre turning lane at signalised intersection.

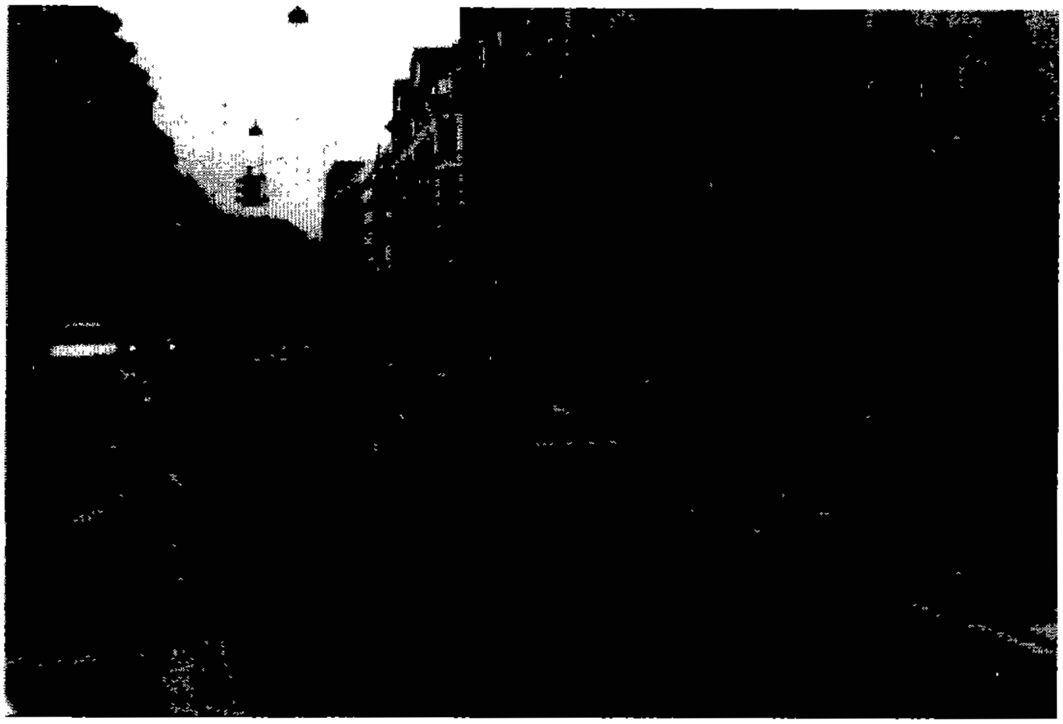


Photo 10: **Strandvejen (site of two previous photos).**
(Traffic road, 50 km/h speed limit)
Note: Wide pedestrian refuge. Footpath extension into parking lane. Bollards and trees to emphasise extension. Narrow visual appearance.

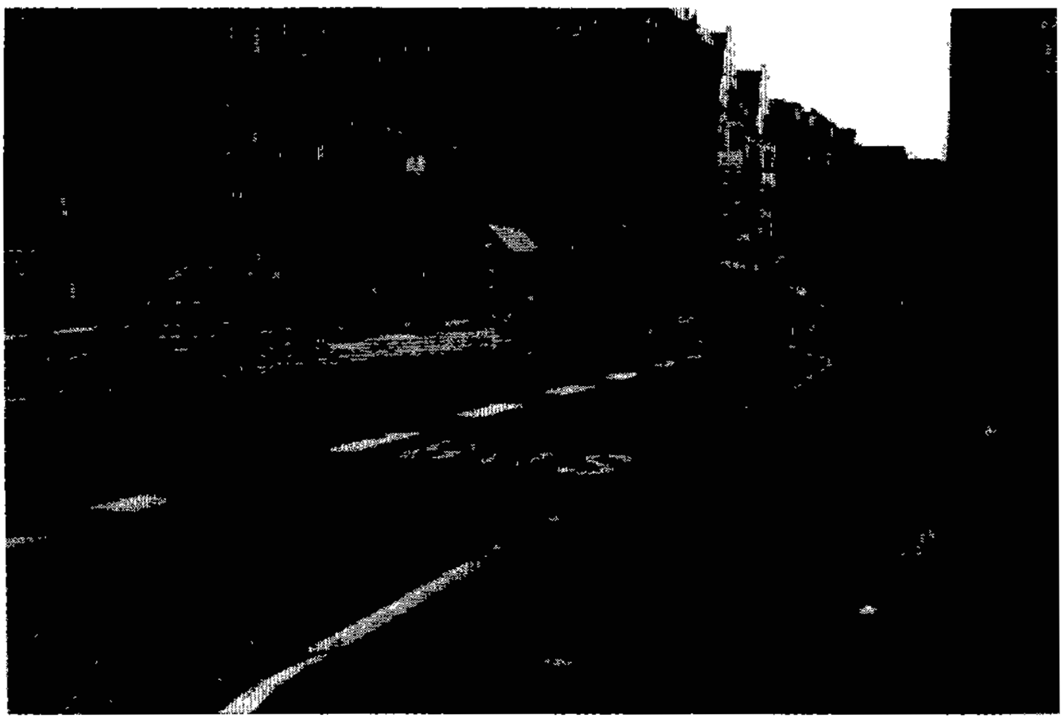


Photo 11: **Strandvejen.** (Traffic road, 50 km/h speed limit)
Note: Bus parking bay. Wide bicycle path, with kerbs between road and footpath.

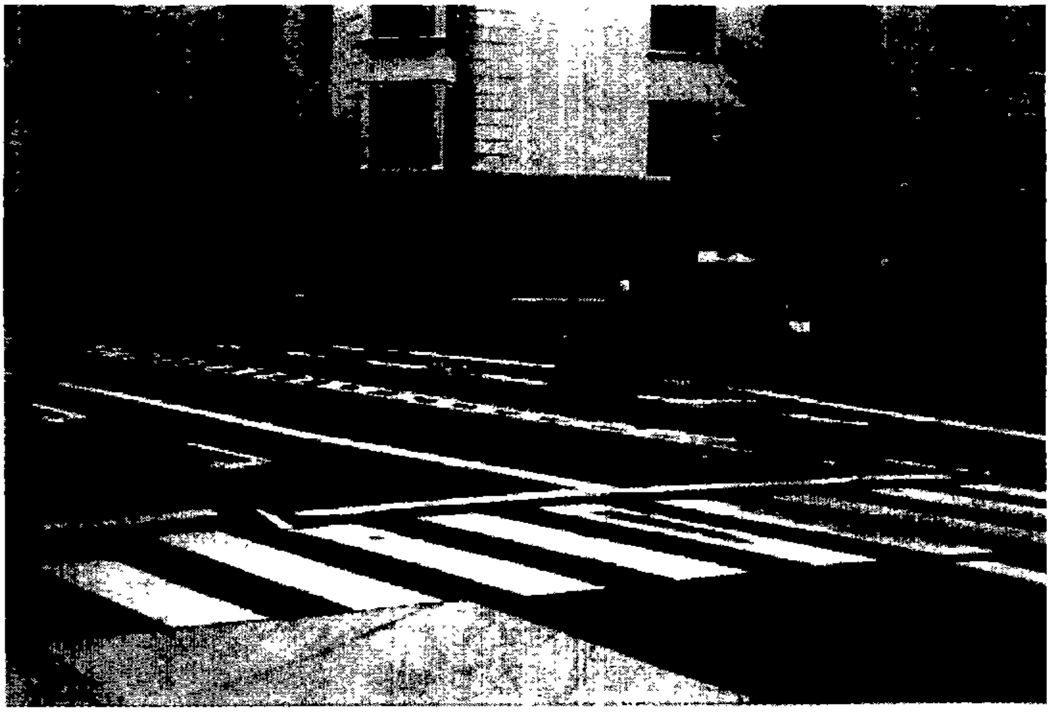


Photo 12: **Strandvejen, at Hellerupvej.** (Traffic road, 50 km/h speed limit)
Note: Closure of minor street entering near major intersection. Road reserve of closed street allows provision of parking bays.

Photo 13: **Herlev (suburb of Copenhagen).**
(Entry to local road (near railway), 30 km/h advisory speed limit)
Note: Roadway narrowing with gateway appearance. Pavement rises onto cobble stones. Posts and shrubs.

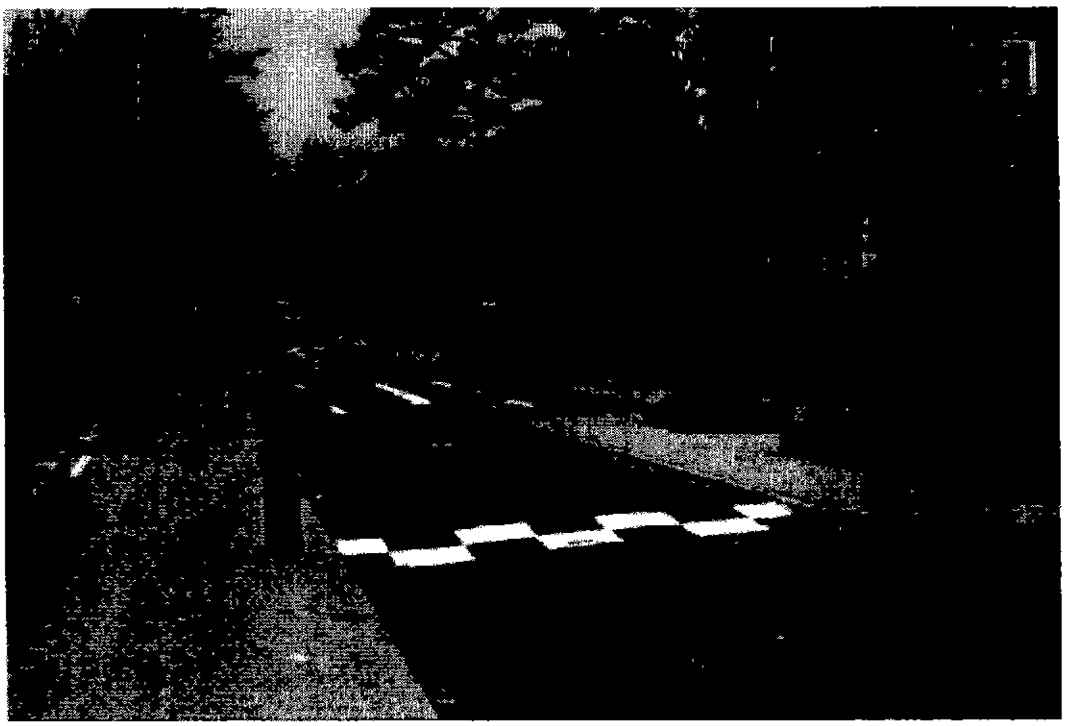
Photo 14: **Herlev.** (Local road (near library), 15 km/h advisory speed limit)
Note: Pedestrian priority area. Distinctive pavement treatment.
Parking allowed in area. Substantial trees and bushes.

Photos
15 & 16: **Herlev.** (Entry to local road, 50 km/h speed limit (30 is aim))
Note: Pavement rises onto cobble stones. Gateway appearance.
Rumble stones preceding gateway. 30 km/h speed limit <u>not</u> posted.
Attention to environmental beauty.

Photo 17: **Herlev.** (Local road (near shops), 50 km/h speed limit (30 is aim))
Note: Very wide pedestrian crossing, using contrasting paving bricks. Crossing also marked on bicycle path. Pavement narrowed at crossing.

Photo 18: **Herlev.** (Traffic road (near school), 50 km/h speed limit)
Note: Raised pedestrian crossing with cobble stone approaches. Central island/refuge with trees and shrubs. Bicycle path provided at crossing. (Off-road bicycle path existed to left of photo, on school side of road.)

Photo 19: **Hareskoven (suburb of Copenhagen).**
(Traffic road (through residential area), 40 km/h speed limit)
Note: Narrow pavement (2 traffic lanes). Heavy trucks prohibited. Parking bays. Raised paving bricks (hump) at entry. Frequent use of circular humps along route (not shown).



Photos
20 & 21: **Hareskoven.** (Local road, 30 km/h advisory speed limit)
Note: Narrow pavement (2 traffic lanes). Aggressive slow point (severely restricting speed and movement of traffic). Parking ban through slow point.

Photos
22 & 23: **Lyngby (suburb of Copenhagen).**
(Entry to local road (near railway), 50 km/h speed limit (30 is aim))
Note: Double change in road texture across cobble stones and raised paving bricks. Median and parking bays with trees, shrubs and posts. 30 km/h speed limit <u>not</u> posted.

Photo 24: **Lyngby.** (Traffic road, 50 km/h speed limit)
Note: Pedestrian crossing ("walking legs" out of picture, on lighting stanchions). One traffic lane over crossing. Kerbs extended into traffic lanes. Posts with distinctive markings. Shrubs to narrow visual appearance.

Photos
25 & 26: **Birkeroed (outer suburb of Copenhagen).**
(Traffic road, 60 km/h speed limit)
Note: Wide central non-traffic reserve (formerly a 3 lane road). Central and kerbside turning lanes. Frequent pedestrian refuges. Wide bicycle paths on both sides, with kerbs between road and footpath.

Photos
27 & 28: **Fredensborg (North Zealand).**
(Roundabout on traffic roads, 70 km/h speed limit)
Note: First (antique) and most beautiful roundabout in Denmark.
Separate peripheral bicycle path. Note antique lighting.

Photos
29 & 30: **Strandvejen, Humelbaek (near Helsingor, North Zealand).**
(Traffic road, 50 km/h speed limit)
Note: Narrow pavement (2 traffic lanes). Staggering of right traffic lane. Parking bay near shops. Wide median with trees and grass. Formerly a 3 lane road.

Photos
31 & 32: **Intersection of Falkoner Alle and Agade, Copenhagen.**
(Traffic roads, 60 km/h speed limit)
Note: Marked (blue) bicycle path across path of right turning cars at intersection. Integration of bicycle path and right turn lane on approach to intersection. Rumble white line between them.

Photo 33: **Rolighedsvej, Copenhagen.**
(Traffic road (bus stop), 50 km/h speed limit)
Note: White painted bicycle path section to indicate pedestrian priority over cyclists when the bus has stopped. Rumble strip on road side of bicycle path to warn cyclists of pedestrians (illegally) standing at kerb to hail bus.

EVALUATIONS OF SPEED LIMITS AND SPEED CAMERA ENFORCEMENT IN THE NETHERLANDS

Report based on visit to SWOV by Chris Brooks, FORS

Summary

Rural speed limits for passenger cars were revised in 1988, from a flat general limit of 100 km/h to limits of 80, 100 and 120, depending on road geometry: as a measure to combat widespread disregard of posted limits, and thus improve safety.

This change was followed by a reduction in measured speeds (mean and $V_{(85)}$) on both 100 and 120 km/h roads. There was also a reduction in crashes.

By 1990, both speed and crash statistics appeared to be reverting to pre-change levels, particularly on the higher-speed-zoned roads. However, there was no evidence that higher limits had had an adverse effect on safety.

These results are generally consistent with other findings documented in the Monash literature review, regarding:

- *the close link between actual speeds and road safety on a given stretch of road*
- *the complex and sometimes paradoxical relationship between speed limits and actual speed distributions.*

Controlled studies of enforcement of speed limits on selected 80 km/h rural roads, using unattended speed cameras in combination with warning signs, have shown a marked reduction in the incidence of illegal speeds. There was also a marked reduction in crashes.

Speed-radar-controlled advisory signs designed to keep passenger cars within a 60-80 km/h range seem to have had relatively little effect at the lower end of the speed distribution —but the initial percentage of vehicles travelling at low speeds was very small.

I discussed speed issues with Ir OEI Hway - liem, who also provided the material included in the attachments to this report. My thanks to Liem for his time, enthusiasm, and good Dutch coffee.

1988 SPEED LIMIT CHANGES

Before 1 May 1988, the Netherlands had a "flat" speed limit of 100 km/h on rural roads for light vehicles, with an 80 km/h limit for heavy vehicles (60 for articulated vehicles on minor rural roads).

From May 1988, speed limits were tailored to road type:

- 120 km/h on freeways (general limit: some road segments zoned to 100)
- 100 km/h on motorways
- 80 km/h on other rural roads

Limits for heavy vehicles initially remained at 60/80 (the special limit for articulated vehicles on minor rural roads was later raised to 80).

Compliance with the general 100 km/h limit had been poor. The new limits were introduced in the hope that more differentiated limits, related to road standards, would help achieve better compliance.

An evaluation study (Roszbach and Blokpoel 1991) documents the following results.

Actual speed changes

- On freeways, the increased limit was followed by a *reduction* in actual mean speeds and $V_{(85)}$, at least in the short term (tables reproduced at Attachment A to this paper).
    - Mean speeds of passenger cars dropped from 113 in April 1988 to about 109 in May/June, and $V_{(85)}$ dropped from 128 to 122.
    - There was even some reduction in speeds of heavy vehicles, for which the limit had not changed.
    - However, a year after the changes, speeds had reverted to around April 1988 values, and remained fairly stable through 1990.
- On motorways, where the limit of 100 remained unchanged, there was a larger speed reduction. This effect has worn off to some extent, but there appears to have been some long term reduction for both passenger cars and heavy vehicles (for example, the passenger car $V_{(85)}$ dropped from 125 to 112 initially, and seems to have levelled out at around 118 in 1990 — details at Attachment A)

As an aside, it is interesting to note that the nominal difference of 20 km/h between speed limits on the two road types produces an actual difference of about 8 km/h in both mean speeds and $V_{(85)}$. The special limit for heavy vehicles produces an actual speed differential (heavy vs passenger) of about 17 km/h on motorways, and 23 km/h on freeways.

Crashes

Detailed results are available only for freeways, though some figures are reported for rural roads in general.

Changes in crash statistics were *broadly* in line with what might be expected, given changes in actual speeds (see graphs reproduced at Attachment B):

- In the period May-December 1988, there was some reduction in freeway crashes at all levels of severity (fatal, serious injury [hospitalisation] other injury and property damage), compared to the same period in 1987.
- For most severity levels (except SI), this drop contrasted with an *increase* from 1986 to 1987.
- Serious injury crashes showed the least improvement, fatal crashes the most.
- Figures for May-December 1989 were close to the 1987 figures for all four severity levels.

The following table, which I compiled from raw data reported by Roszbach and Blokpoel (1991), provides a further perspective (note that unlike the graphs, the table is based on persons, not crashes):

		12 months ending April		
		1988	1989	1990
Total rural				
	fatalities	958	832	973
	Injuries	16298	14500	16522
100/120 limit roads				
	fatalities	159	121	172
	Injuries	2594	2206	2756

INDEX		*12 months ending April*		
		1988	1989	1990
Total rural				
	fatalities	100	87	102
	Injuries	100	89	101
100/120 limit roads				
	fatalities	100	76	108
	Injuries	100	85	106

Roszbach and Blokpoel report that the 1988 (May-December) figures for fatalities, serious injuries and other injuries are below the long term linear trend (85-89 [sic]), but for 1990, departures from the linear trend were not significant (with other-injury figures being above the trend line).

Heterogeneity of 80 km/h roads

The rural roads zoned to 80 km/h vary considerably in standard:

(1) two-lane roads open only to "fast" traffic

(2) two-lane roads open to all traffic

(3) single-lane roads open to all traffic

Observations of actual speeds on these roads produced $V_{(85)}$ values of 92, 90 and 80, respectively (Oei 1991 a).

Consideration was given to raising the limits on higher quality roads (types 1 and 2) to 90 km/h, but this has not been implemented.

SPEED CAMERA ENFORCEMENT TRIALS ON 80 KM/H ROADS

More recent speed experiments have focused on speed controls on 80 km/h limit two lane rural roads, using a combination of interactive signs and radar enforcement.

- note that this involved heavy enforcement of a limit below the magic $V_{(85)}$.

An English-language report is available (Oei 1992, attached). In brief:

The trials covered two road types:

- roads closed to slow traffic (tractors, mopeds, etc), where the objective was to reduce both high (>80) and low (<60) speeds
- roads open to all traffic, where the objective was to reduce high speeds only.

For selected experimental and control roads, traffic speeds and crashes were measured in three phases:

- control (Phase 0)
- warning period (Phase I)
    - on restricted-vehicle roads: fixed signs showing "safe speed 60-80" and automatic signs controlled by speed radar flashing "60-80" when a passing vehicle was detected outside this speed range
    - on all-vehicle roads: fixed signs showing "max. speed 80" and automatic signs controlled by speed radar flashing "You are driving too fast" when a passing vehicle was detected above the speed limit

- enforcement period (Phase II): with fixed-position unattended speed cameras placed *after* the fixed and variable warning signs (the Dutch authorities really do try to give motorists a sporting chance!): infringement notices were issued for excessively high speeds only (not low speeds)

Results

The intervention was successful in reducing speeds: mean speeds, $V_{(85)}$ and the percentage of drivers above 80 km/h were reduced on both road types (pages 7-9 of attached paper) —and reductions on treated roads were clearly greater than on control roads.

There was an initial reduction in Phase II (warnings only) and a further reduction in Phase II (enforcement).

On the roads closed to slow traffic, the "60-80" signs did not reduce the proportion of vehicles travelling below 60: in fact this proportion increased and $V_{(15)}$ on these roads decreased. However, speed variance did decrease, since $V_{(85)}$ decreased more than $V_{(15)}$. (page 7 of attached paper). It is worth noting that the initial proportion of vehicles travelling below 60 was very small (1.3%).

- Note that there was no direct test of the speed dispersion theory prediction that speeding up the slowest traffic will reduce crashes: that is, there was no trial in which an attempt was made to speed up slow traffic without changing speeds above $V_{(50)}$.

The incidence of crashes decreased on treated roads, both in absolute terms and in comparison to control roads, (pages 10-11 of attached paper: average crash reduction of 35% on experimental roads, after adjusting for changes on control roads) and SWOV concludes that the intervention was cost-effective (even allowing for the significant vandalism of the unattended speed cameras that was observed during the trials) .

Comment

The observed crash reduction is remarkably high, given that the reduction in $V_{(85)}$ was only about 9%, and the bulk of crashes observed were property damage only.

The Ns reported in the speed distribution tables on pages 7-9 of the SWOV report (Oei 1992, attached) appear to indicate that there was a substantial reduction in traffic volumes on the treated roads, in the post-treatment period. However, a personal communication from Oei makes it clear that the reduced Ns were a function of reduced resources for speed measurement, not a reduction in traffic volumes.

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Roszbach, R. and Blokpoel, A. (1991) *Veiligheidseffecten van de invoering van 100- en 120 km / uur snelheidslimieten op autosnelwegen.* [Safety effects of the change from 100- to 120 km/h speed limits on freeways] SWOV Report R-91-95 (Dutch language).

ATTACHMENTS: same as in original report

ATTACHMENT A

Tables and graphs from Roszbach, R. and Blokpoel, A. (1991) *Veiligheidseffecten van de invoering van 100- en 120 km/uur snelheidslimieten op autosnelwegen.* [Safety effects of the change from 100- to 120 km/h speed limits on freeways] SWOV Report R-91-95

Attachment

Comments on Paper "Did the 65 mph Speed Limit Save Lives" by Lave and Elias

Methodology

- Is it appropriate for the study? Specifically, are fatality rates more appropriate than fatality counts?

  Some argument could be made that fatality rates are a good measure because they account for changes in travel both over time and before vs. after the speed limit increase. In addition, the agency uses changes in the fatality rate over time to track overall safety progress. However, it is not clear that this is the only way or the best way to conduct the analysis, as the authors allege. Lastly, it is possible that a reasonable assessment could be made using fatality rates if properly applied.

- Is it correct to combine crashes occurring on rural interstates (where the speed limit increase occurred) with crashes on nonrural interstates where there was no speed limit change?

  We believe that this approach has shortcomings. Rural interstate fatalities comprise only 7 percent of total fatalities in 65 states. Therefore, considering statewide fatalities as the measure of safety gives a great deal of weight to the 93 percent of fatalities occurring on roads with no change in speed limit. In addition, factors beyond those considered in the report (belt use laws, percent unemployment), such as the reduction in alcohol involvement, increases in belt use (both in law and nonlaw states) could affect the 93 percent of fatalities that occurred on roads unaffected by the speed limit increase, clouding possible interpretations of change.

  Considering total fatalities as the measure of effectiveness includes both pedestrian and heavy truck fatalities. Pedestrians (whose 7,400 fatalities comprise about 17 percent of total fatalities) would not be expected to shift their walking to interstates because of a higher speed limit.

  Because of their travel pattern, heavy trucks generally already traveled on interstates when the speed limit was 55 mph; their travel patterns would not be expected to change with the increased speed limit (however, while their exposure might change little, their accident involvement and severity would likely be affected by higher speed limits).

Urban travel patterns also would not be expected to change in response to an increased speed limit on rural interstates. Thus, the use of overall fatality rates dilutes the effect of the increased speed limit and may confuse observed changes with other factors not related to the adoption of the 65 mph speed limit.

- How accurate is VMT for individual highway systems, such as rural interstates compared to statewide estimates for the entire roadway system?

  While we believe that vehicle miles traveled data are reasonably accurate for individual highway systems, the authors have done some questionable manipulations to the data. Monthly VMT were estimated by the authors, as described in footnote 3 on page 16 of the report, using FHWA's annual VMT for each state and the results of the National Personal Transportation Survey (NPTS) quarterly pattern. At a minimum, this would add sampling error to the VMT estimates, which was not accounted for in the analysis conducted. In addition, there is no apparent reason to conduct the analysis on a monthly basis if data are not available. This is a real weakness of the analysis. Lastly, it is not reasonable to believe that monthly VMT proportions are constant, or even similar, across the various regions of the country since seasonal variations differ across the regions.

- Are safety belt laws adequate substitutes for reported safety belt use levels?

  Safety belt use rates would provide more detailed information and would be preferable. However, the use of dummy variables to represent the absence/presence of belt use laws is a reasonable surrogate to account for the change in use law status (pre vs. post). However, differential changes in use between 55 and 65 states (within each of the law/nonlaw groups) are not accounted for. Footnote 1 on page 8 of the report alleges that the two groups were comparable. No source of data is provided for the authors statistics.

- Is the comparison of 65 mph and non-65 mph states appropriate even with explicit modeling?

  One outcome of the Congress permitting states to increase their speed limits is the concept of "self-selection bias". That is, the fact that a state has chosen to increase it speed limit probably makes it different from those states that did not. At a minimum, the states that have not increased speed limits are generally on the east coast and exhibit greater population/traffic densities. In general, the use of comparisons of state fatality rates has been and continues to be discouraged since differences can be attributed to climatological, demographic and topographical differences. Even though the current analysis contrasts trends in 65 vs. non-65 states (rather than the current absolute fatality rate) the question arises about whether the two groups of states would be expected to behave the same had there been no increase in speed limits. This has not been suitably addressed by the authors.

The authors found that the fatality rate in 65 states declined to a greater extent than in 55 states. In fact, the raw data show that overall, the 38 states that raised their speed limits to 65 mph experienced the same 17 percent decline in fatality rates as the states that retained their 55 mph speed limit. Whether this is greater than or less than what would have been expected in the two state groups requires additional analysis.

The Authors' Theory

o Are the three tenets of the "theory" adequately supported by data? This is, did drivers switch to safer roads (rural interstates) after passage of the 65 mph law?

  There is evidence that growth in VMT on 65 rural interstates increased faster (relative to VMT on other roads) after the speed limit was changed. In 1986, before the 65 mph speed limit, rural interstate travel in the 65 states comprised 9 percent of the total. In 1990, rural interstate travel in these states comprised 10 percent of the total. Therefore, the premise of a systemwide effect would be based on a relatively small shift in travel between 1986 and 1990. If drivers shifted from 55 interstates to 65 interstates, that is not necessarily a shift to a safer road; 65 mph interstates have higher fatality rates than do 55 mph interstates. However, 65 interstates have lower fatality rates than do 55 noninterstates. Again, it is possible that some level of additional safety was gained from such a shift. However, it should only apply to the tradeoff between competing routes of travel. As stated earlier, urban travel does not appear to compete with higher speed rural interstate travel and should not be "eligible" under the tradeoff scenario.

o Were highway patrol activities shifted to nonrural interstates following passage of the 65 mph law?

Section V on page 11 of the report documents the existence of letters from a number of states responding to a request for information, and presented in the 1989 NHTSA Report to Congress on the effects of the 65 mph speed limit through 1988. However, some of TSP's contacts may be able to provide this information.

- o Has the speed variance among cars declined following passage of the law?

  The authors hypothesize that speed variance may have decreased when the speed limit was raised to 65 mph. In fact, based on data submitted to NHTSA by 18 states that raised their speed limits, speed variance increased between 1986 and 1990 in the 65 states, with the largest increases occurring at the highest speeds.

Method of Analysis

- o Is the method of analysis approgriate? That is, if the change to 65 mph speed limit does result in a decrease in the fatality rate, one would expect that as states changed to the higher speed limit, the trend in fatality rates would decrease after the change. Does the method of analysis used demonstrate this change? Does the method of analysis used show that if there is change, that this change differs from what would be expected from prior fatality rate trends?

  The authors provide no information concerning the overall trend in fatality rates, or divergences from that trend. Rather, Table 1 on page 9 of the report presents estimates of the change in statewide fatality rates for 65 states and 55 states, using 1986 as the base. As discussed earlier, the premise is that 55 states are a "control group" for the 65 states. We do not believe that this is valid as there has been no justification for the assertion that the experience of 55 states historically parallels that of the 65 states. If the author's argument that increased speed limit on rural interstates was an incentive that pulled traffic from competing roads, then the trend in urban fatalities within the 65 states should provide a better comparison series for their analysis. This was not investigated in the report.

- o Does averaging fatality rates across states tend to mask individual state fatality rate trends?

  Aggregating state fatality rates will mask individual state fatality rate trends. However, the concept of modeling the pooled data is a valid approach to estimate the overall effect of the 65 mph speed limit. This is not to say that we concur with their results.

SPEED ENVIRONMENT DESIGN WORKSHOP
CANBERRA 22 & 23 NOVEMBER, 1992

RECENT DEVELOPMENTS IN SPEED MANAGEMENT IN VICTORIA

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SPEED MANAGEMENT IN VICTORIA

1. INTRODUCTION

In the years between 1987 and 1991 speed management in Victoria had been guided by the *1987 Speed Management Strategy* (R.T.A. (1987)) developed by a widely representative working group convened by the then Road Traffic Authority. The 1987 strategy was generally held in high regard as the first attempt to put in place a comprehensive, integrated program of education, publicity, enforcement and speed zoning.

However, almost from the day of its acceptance by the State Government, the aims of the strategy had begun to be compromised by political interference and localized resistance. So much so that in later years the speed zoning system was coming under-increasing criticism because of perceived anomalies, primarily on the urban arterial network.

In the face of this criticism, made more vocal by the increased intensity of the speed camera program, the Minister for Transport, in 1990, commissioned the all party Parliamentary Social Development Committee to conduct an inquiry into speed limits in Victoria. The SDC received numerous submissions from concerned individuals and municipalities, and interviewed a large number of expert witnesses in conducting its inquiry.

The final report of the SDC was published in November 1991 (S.D.C. (1991)). In general the report endorsed the philosophies of the *1987 Speed Management Strategy* and the use of the expert system "VLIMITS" in setting speed limits. The report included 31 recommendations ranging from the need for fundamental research into the relationship between speed and accident occurrence, to enforcement strategies, signing techniques, and processes for setting speed limits.

The Kirner Government's response to these recommendations, developed in consultation with a Speed Management Policy Committee convened by VIC ROADS, was tabled in the Victorian Parliament on 19 May 1992. Key features of the response were commitments:

* to a comprehensive review of speed limits over the following 12 month period to phase out existing 75 km/h zones in favour of a rationalised system utilising 10 km/h increments;

* to achieving lower speeds in residential streets, and;

* retaining 100 km/h speed limits as the maximum permissible in the State of Victoria.

These commitments were the catalyst for the development of a new set of guidelines for setting speed limits in Victoria. Preliminary work on the new guidelines was co-co-ordinated by the Speed Management Policy Committee and a draft proposal for comment circulated to all municipalities and other interested parties on 15 September 1992.

Essential elements in the draft proposal were:

. establishment of a grid of traffic routes across the metropolitan area, to be signed at 60 km/h or above, to promote effective traffic flows and mobility for motorists;

. a new 50 km/h general urban limit to apply to collector and other non-arterial roads not otherwise signed;

. the use of sign posted 40 km/h zones on some small selected local residential streets under specified conditions;

. the availability of time-based speed zones signed at 40 km/h or more in the vicinity of schools, strip shopping centres and other community facilities, again under specified conditions, and;

. the retention of the maximum 100 km/h speed limit.

The remainder of this paper discusses two of these elements in more detail, specifically;

(i) the background and reasons behind the recommendation for a general urban limit of 50 km/h to achieve the lower speeds in residential streets; and;

(ii) the results of an analysis of the effects on accidents of the previous period during which speed limits on some selected Victorian roads were raised to 110 km/h (June 1987 - September 1989).

2. WHY A 50 KM/H GENERAL URBAN LIMIT?

2.1 Background

Two of the recommendations contained in the Social Development Committee's final report (*Social Development Committee (1991)*) related specifically to the issue of speed limits in residential streets, viz;

> *Recommendation 11. **The Minister for Transport amend the Road Safety (Traffic) Regulations to set the speed limit for residential streets at 40 km/h.**
>
> *Recommendation 12. **The Minister for Transport amend the Road Safety (Traffic) Regulations to enable local government in conjunction with VIC ROADS to nominate residential streets in which other speed limits will apply.**

The Committee made these recommendations after receiving what it considered to be "overwhelming evidence in support of lower speed limits in residential streets".

The Government response to these recommendations supported what it believed to be the intent of the SDC, i.e., to achieve lower traffic speeds in quiet residential or local streets. However the response questioned whether the use of reduced speed limits was necessarily the most appropriate means of satisfying that intent, particularly as previous trials had indicated that reduced speed limits in residential areas had had little effect on speeds unless they were supported by other measures. The response also highlighted some of the difficulties associated with a general change of the nature recommended by the SDC and concluded that VIC ROADS, through the establishment of a Speed Management Policy Committee (SMPC), should investigate the most appropriate means of achieving lower speeds in residential streets.

In it's report the SDC acknowledged that previous studies had indicated that speeds in local streets were generally <u>not</u> high compared to the existing 60 km/h general urban limit. Nevertheless the sensitivity of the issue was plainly clear from the amount of correspondence and public debate which was generated by the SDC recommendations. None of this comment has, however, opposed the objective of reducing traffic **speeds** on local streets.

The SMPC considered a number of options for achieving lower speeds in residential streets which are discussed in more detail below. These options were considered in the context of the <u>overriding</u> objective for speed management to provide a credible system of speed zoning which meets driver expectation while achieving a balance between traffic safety and mobility.

<u>2.2 Description of Problem</u>

In order to gain a better description of the problem the SMPC firstly looked at what was known of speed and crashes in local streets from previous studies in Melbourne.

From this review a number of points could be drawn together to provide a description of the "problem" of speed and safety in residential areas.

(i) In the metropolitan area the vast majority of accidents occurring off the arterial network occur on collector roads or on local streets that function as collectors.

(ii) In the absence of any devices to slow traffic speeds, current 85%ile speeds are generally within 5 km/h of the existing 60 km/h limit.

(iii) There is a significant gap between people's attitudes as residents and their behaviour as drivers in residential areas.

(iv) There is an increasing public demand for action to be taken to reduce speeds in residential areas, a demand which had been fuelled by the SDC recommendations and the public debate which followed.

2.3 Discussion of Problem

The above points paint a picture of a "problem" which is perhaps more perceived than actual.

On the basis of the previous studies, compliance to a speed limit significantly lower than 60 km/h (i.e. 40 km/h) could not be expected without the use of physical devices or widespread enforcement. While the technology now exists to implement more widespread enforcement (i.e. speed camera's), enforcement of a speed limit which is significantly lower than driver expectations is at odds with the fundamental objectives of speed management and is therefore likely to lead to more widespread animosity toward the enforcement agency.

Nevertheless the SMPC acknowledged that the existing system of speed zoning (i.e., a general urban limit of 60 km/h for all roads) sends no signals to drivers that they should drive any differently on local streets than they do on arterial roads of the same limit. Recent surveys conducted by the both the NRMA in New South Wales (Oct/Nov 1991) and the RACV in Victoria (RACV (1992)) have indicated that drivers now, more than ever, are prepared to accept the notion of a graduated system of speed zoning. In NSW 84% of respondents supported the concept of setting speed limits to match the safety of a road and its surrounding environment, and 83% said that they would then be more likely to stay within the posted speed limits. In Victoria 70% of respondents preferred some reduction in speed limits for non-arterial roads with the majority favoring a 50 km/h limit.

The SMPC concluded that there was some logic in, and certainly some support for, a change to the existing system.

2.4 Options Considered to Achieve Lower Speeds in Residential Streets

In developing and considering various options for change the SMPC was influenced by the following needs for the new system:

(i) that any change adopted should address the "real" problem as well as the perceived problem, and,

(ii) that any change adopted should contribute towards a <u>long term</u> goal for speed management in residential streets by favourably influencing driver attitudes and behaviour in the long term, and,

(iii) that any change adopted should not affect the credibility of the rest of the speed zoning system.

The options considered by the SMPC are listed below:

Option 1 - The establishment, through a change to the regulations, of a second level blanket speed limit (either 40 km/h or 50 km/h) to cover non-arterial roads, and supplement the existing 60 km/h general urban limit.

Option 2 - Lowering the general urban limit to 50 km/h with arterial roads being signed upwards at 60 km/h or above, and retaining the option to set lower limits where physical devices have been installed.

Option 3 - Retaining the existing 60 km/h general urban limit and signing downwards for non-arterial roads.

Option 4 - Lowering the general urban limit to 40 km/h and signing upwards for roads other than short local streets.

The attached Table 1 summarizes the advantages, disadvantages, cost, suitability for local area and other comments considered.

Many of the submissions received following the release of the SDC report raised the question; should the blanket speed limit in residential streets be 40 km/h, as recommended by the SDC, or was 50 km/h a more reasonable value?

The argument in favour of a 40 km/h speed limit is based almost solely on the belief that the lower speed limit will result in a lower number of accidents. Studies from overseas tend to support this belief although it is by no means obvious that these results can be translated to Australian conditions and drivers.

Arguments in favour of a 50 km/h limit include-

* credibility - the 50 km/h limit is seen as being a more realistic and credible reduction from the existing limit of 60 km/h and therefore more likely to achieve a higher level of compliance. The importance of achieving credibility in the speed zoning system must not be undervalued as it is the essential ingredient in achieving long term behavioural change through enforcement - the only mechanism that we know will lead to a generalisation of the forced behaviour change desired.

* rationality - the 50 km/h general limit for local streets is seen as being a logical step in a progressive graduated speed zoning system, with 40 km/h being reserved for "special" locations such as schools or other areas of high pedestrian activity.

* cost - while the cost estimates in Table 1 do not include the cost of installing physical devices, it is expected that a 40 km/h limit would lead to greater pressure on local government to install these devices in a larger number of streets as residents perceive a large number of drivers not complying with the 40 km/h limit. Local government may therefore be required to spend considerably more on local street treatments to satisfy changed community expectations.

* National uniformity - although there is currently little activity in the other states in moving towards a change in the general urban limit it is known that NSW in particular are firmly committed to the 50 km/h value. There would be significant benefits in having uniform laws regarding urban speed limits applying throughout Australia, rather than each state going it's own way.

In view of the above considerations it was considered that, on balance, Option 2 represented the most effective and practical solution to meet the demands of all of the parties involved; residents, drivers, Local Government and Police; and most effectively met the key needs set out above. In particular it provides a clear heirarchy of speed limits to motorists, an element which was seen as crucial in achieving the long term attitudinal change sought.

In future, new subdivisions will be able to be designed and built to support this speed heirarchy, reducing the dependance on introduced speed management devices or enforcement for speed control.

3. PREVIOUS EXPERIENCE WITH A 110 km/h SPEED LIMIT

During it's inquiry into speed limits, the Social Development Committee looked in detail at the possibility of re-introducing 110 km/h speed limits onto selected Victorian freeways. These roads had previously been zoned up to 110 km/h as part of the implementation of the 1987 Speed Management Strategy in June 1987, but, in response to a rising road toll in 1989, this decision was reversed and the speed limits returned to the previous limit of 100 km/h in September 1989.

During the inquiry the SDC had asked for an analysis of crash rates on those freeways which had been zoned at 110 km/h. Due to limitations on time and data availability this analysis was unable to be completed, but preliminary results indicated some cause for concern.

Subsequently the SDC moved from a position of favouring the re-introduction of 110 km/h limits to recommending only that the research be finalised and the issue considered by the Road Safety Co-ordinating Council in the light of the study results.

The analysis was completed in June 1992 and is soon to be released in a report titled *"110 Kilometre per hour Speed Limit - Evaluation of Road Safety Effects"* by J. Sliogeris.

The study utilised casualty accident data during three different periods; "Before 110", "During 110", and "After 110", each spanning approximately 2.1/2 years. A before and after study design with control groups was used with the main reporting variable being casualty accident rate per kilometre travelled.

Available speed data, and the results of similar studies from overseas were also reviewed.

The major results of the accident analysis are summarised in Table 2 below. Overall the results show a 24.6% increase in casualty accident rate per distance travelled following the raising of the speed limit in 1987, and a 19.3% decrease following its removal in 1989 (after allowing for the control group pattern).

Similar results were found in sub-groupings by urban/rural, standard of freeway and by accident severity.

Road Safety Effect of 110 km/h Speed Limit

Grouping	"Before 110" vs "During 110" Comparison % change	"During 110" vs "After 110" Comparison % change
Total Victoria		
Overall Victoria	+24.6%	-19.3%
Rural/Urban		
Rural	+14.8%	-16.8%
Urban	+48.9%	-11.7%
Rural by Freeway Standard		
Low Standard	+20.1%	-23.1%
Medium Standard	-8 2% NS	-24.8%
High Standard	+26 7%	-5.7% NS
High Severity Accidents Only		
Victoria High Severity	+21.5%	-18 2%

NS: Not Statistically Significant

These results are not dissimilar to the results of similar studies conducted in Europe and (mainly) the USA. These studies provided clear quantitative evidence that raising speed limits had increased road accidents and, while the exact values may be arguable, the magnitude of the effect was such that there is little doubt that lower speed limits did save lives and reduce injuries and accidents.

While the scope of this study was essentially limited to investigating the accident trends on those freeways zoned at 110 km/h during the study period, it was considered that some comment on travel speeds, one of the more likely explanatory variables, was warranted.

A review of available Victorian, NSW and US speed data and analysis suggested that the increase in speed limit to 110 km/h would only result in a small increase in average speed (say 2 to 4 km/h per 10 km/h speed limit change) in the short term for rural freeways and only small changes in the variance of the speed. However the greatest change which occurs is the number of vehicles exceeding

Available evidence suggests that with minimal levels of enforcement about 50-60% of cars will travel over 110 km/h and about 12-20% over 120 km/h. On a 100 km/h zoned freeway the respective percentages are estimated to be 30-40% of cars travelling over 110 km/h and 5-10% over 120 km/h. Thus in practical terms the 100 km/h limit does have a dampening effect on the speed distribution, and moderate the average and higher speed drivers.

Nevertheless as the underlying philosophy behind speed management is to balance the competing needs of road safety and mobility, and given the stated policy of the new Kennett Government to reintroduce 110 km/h limit on Victorian Freeways and the apparent Victorian community preference for a higher speed limit on high standard rural freeways as indicated in the RACV (Nov. 1992) survey the SMPC has recently given consideration to, and endorsed guidelines for the restricted use of 110 km/h speed limits.

These guidelines are more restrictive than those contained in the *1987 Speed Management Strategy*, and confine the use of 110 km/h limits to those higher standard rural freeways which are characterised by their interstate or inter-regional transport function with predominantly long trip lengths.

A copy of the guidelines is attached.

JC2325.RES

REFERENCES:

ROAD TRAFFIC AUTHORITY (1987) Speed Management Strategy.

SOCIAL DEVELOPMENT COMMITTEE OF VICTORIA (1991) - Inquiry into Speed Limits in Victoria.

J. SLIOGERIS (1992) - 110 Kilometre per hour Speed Limit - Evaluation of Road Safety Effects.

ROYAL AUTOMOBILE CLUB OF VICTORIA (1992) - RACV Member's Comments on Speed Limits.

ABLE 1 - SUMMARY OF EACH OPTION

Option	Advantages	Disadvantages	(Metro Only) Cost	Suitability for local area (Level of effectiveness)	Other Requirements
1	• Relatively quick and cheap to implement	• No obvious change in environment and will need signing and extensive publicity campaign. • Requires change in legislation • May lead to confusion during reseals and on unsealed roads. • Compliance to blanket speed limits is likely to be very low without speed management devices. • Requires removal of existing centrelines on collector roads.	$2 9M if second order limit is 40 km/h $2.5M if 50 km/h $1M for publicity campaign	Local areas with local streets that: • abut collector roads only • abut collector and arterial roads provided roads are narrow and in short lengths. Unlikely to be effective in most older areas.	• Would require speed management devices on roads that do not support lower speed environments in local streets • Requires high level of enforcement in local streets.
2	• Many urban arterials are already signed at 60 km/h • Establishes a clear heirarchy of roads • In line with National approach as we know it • Only one blanket speed limit	• Does not change the physical environment on collector roads and therefore may not be effective in reducing speeds on this type on this type of road. • Requires change in legislation • Compliance to lower limit likely to be low without speed management devices	$3 4M plus $1M for publicity campaign	Local areas with local streets that: • abut collector roads only • abut collector and arterial roads. • abut arterial roads provided roads are narrow and in short lengths, and, streets that do not support 50 km/h are treated with speed management devices.	• Requires enforcement or psychological speed reduction measures to ensure compliance to 50 km/h on collector roads •
3	• No change to legislation required so could be commenced immediately	• Motorists are likely to receive confusing message unless all roads are signed downwards consistently (anomalies are likely to occur) • Present experience indicates low level of compliance without speed management devices or enforcement. • Relatively expensive. • Saturates local streets with speed limit signs.	$12.2M	Local areas with local streets that: • abut collector roads only • abut collector and arterial roads. Provided roads are narrow and in short lengths. Unlikely to induce any change to present speeds without the use of speed management devices.	• Would require speed management devices on roads that do not support lower speed environment. • High levels of enforcement in local streets to ensure compliance.
4	• Establishes clear heirarchy through use of signs • Deals with all roads including collector • Sends a clear message, as far as the applicable speed to motorists (aids enforcement practicability) • Many urban arterials are already signed at 60 km/h	• Poor compliance expected without speed management devices or enforcement • Needs more extensive use of speed management devices • Change to legislation with accompanying publicity • Will result in a multitude of signs in local streets.	$7 8M plus $1M for publicity campaign.	Local areas with short and narrow local roads that abut collector roads only as longer local roads would enable higher speeds to be achieved. Unlikely to be effective in other types of subdivisions.	Would require extensive use of speed management devices. or High levels of enforcement in local streets

tion 1 - The establishment, through a change to the regulations, of a second level blanket speed limit (either 40 km/h or 50 km/h) to cover non-arterial roads. One option for defining non-arterial roads could be any street in urban area not continuously marked with a centreline.

tion 2 - Lowering the general urban limit to 50 km/h with arterial roads being signed upwards at 60 km/h or above, and retaining the option to set lower limits where physical devices have been installed.
tion 3 - Retaining the existing 60 km/h general urban limit and signing downwards for non-arterial roads.
tion 4 - Lowering the general urban limit to 40 km/h and signing upwards for roads other than short local streets.

GUIDELINES & CRITERIA FOR THE RE-INTRODUCTION OF 110 km/h SPEED LIMITS IN VICTORIA

Background

In 1987 a widely representative task force prepared a report on a speed management strategy for Victoria. This included a recommendation to introduce a sign posted speed limit of 110 km/h on sections of arterial routes constructed to freeway standard.

This recommendation was subsequently adopted by the Government of the day and implemented. However in view of concerns about the high accident rate experienced in 1989, the 110 km/h speed limit was withdrawn and the freeway sections involved reverted to 100 km/h speed limit.

Subsequently in 1990/91, the question of the 110 km/h speed limit was considered by the Social Development Committee of the Parliament of Victoria and their report recommended that VIC ROADS complete its study comparing crash rates on freeways and expressways which had speed limits of 110 km/h; and also that the RSCC examine the suitability of those sections of freeways and expressways where 110 km/h speed limit may be safely applied.

At the time of its initial introduction and after it was subsequently removed the freeway sections with 110 km/h speed limit were evaluated to determine the effects in terms of vehicle speeds and accident rates. (Ref Zutshi Indu 1989 Evaluation of the effect of the introduction of the 110 km/h speed limit in Victoria on vehicle speeds and Sliogeris J. 1992, 110 km/h speed limit - evaluation of road safety aspects.)

The current Government has indicated its policy to re-introduce the 110 km/h speed limit on rural freeways and the following guidelines have been adopted by the Speed Management Policy Committee as a basis for considering 'freeway' sections for speed zoning to 110 km/h.

GUIDELINES & QUALIFYING CRITERIA FOR 110 km/h SPEED ZONES

The following guidelines are based on a review of those used in the original introduction of the 110 km/h speed zones particularly in the light of the results of the road safety evaluation of the higher speed limit by John Sliogeris of Road Safety Division of VIC ROADS. Each individual criteria should not be viewed as an absolute warrant but should be considered in combination with others in judging the suitability of freeway sections for the higher speed limit.

* The route to be considered will be those characterised by their interstate or inter regional transport function with predominantly long trip lengths and on which drivers have a high expectation of emphasis on mobility and safety.

- Sections of routes inside the general urban area of Melbourne and the provincial cities will be excluded. These sections are characterised by traffic having a high proportion of commuter trips, interchanges relatively closely spaced (eg < 3 km) and peak weekday traffic loadings generally greater than 25,000 veh per day.(AADT)

- The high speed limit sections will be constructed with dual carriageways and 120 km/h design speed alignment. However an isolated curve to 100 km/h design speed would not preclude a section provided the shoulders are sealed, the curves are adequately signed and delineated and the accident experience is satisfactory.

- Access will be fully controlled although some "permitted points of access" may exist (generally not more than 2 per km per carriageway). In general entry and exit will be via well spaced interchanges. However some well spaced low volume (<100 vpd) at grade intersections would not exclude the section if the accident history is satisfactory.

- The sections applicable to the higher speed limit should have sealed shoulders and a clear roadside recovery area of 9 m wide outside the traffic lanes. Where rigid objects are within this zone they must be frangible or protected by guardrail.

- Sections of rural freeway meeting the above criteria are to be further reviewed where the accident rate is greater than 0.50 casualty accidents per km/year, (ie one casualty accident per two kilometres),based on accident data for the latest 2 to 3 year period. (Reference could be made to John Sliogeris' report, attachments 3 & 4 initially where appropriate).

- In order to limit the number of speed limit changes along a route to an acceptable level, the higher speed limit should not be applied to a section less than 5 km in length and the matter should be carefully reviewed where any proposed isolated length is less than 10 km.

The application of the guidelines to the existing freeway network (as at October 1992) identifies the sections listed in Appendices A1 to A3 as being appropriate for speed zoning to 110 km/h. These sections have been considered by the Speed Management Policy Committee and recommended for adoption.