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A SIMULATOR BASED EVALUATION OF SPEED REDUCTION MEASURES FOR RURAL ARTERIAL ROADS

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CONTENTS

LIST OF TABLES

LIST OF APPENDICIES

ABSTRACT

In Great Britain accident rates on rural roads are not falling as fast as those on urban roads. In 1993 the number of casualties from accidents on rural A roads was 4% higher than the average for 1981-85, which is the baseline for the Department of Transport target of a one third reduction in road accident casualties by the year 2000. Driving too fast for the conditions is a major factor in accident causation. High speeds in conjunction with the varying geometric conditions common on rural single-carriageway A roads, result in a fatal accident rate which is higher than that for any other type of road.

The aim of the research was to investigate, in a safe and controlled manner using the University of Leeds Advanced Driving Simulator, the effectiveness of a variety of measures for reducing driver speeds on rural single-carriageway arterial roads, in order to identify practical and cost-effective combinations of treatments to reduce both the frequency and severity of accidents on such roads.

Treatments appropriate to each of three situations were investigated. These were: (1) treatments that reduce speed and speed variance on fairly straight roads (general treatments); (2) treatments that reduce curve entry speeds for sharp bends; (3) treatments that reduce speeds on the approach to and through villages. Treatments investigated included the use of road markings to reduce lane width or produce horizontal deflection; the use of signs both on posts and on the road surface; and the use of optical illusions to affect the driver's perception of speed or road width. Many of the treatments have been used previously, but few have been evaluated in a controlled way.

The first phase of the research involved the evaluation of each individual treatment. The treatments were evaluated with respect to their effect on speed, vehicle lateral position, and incidence of overtaking. The second phase of the research involved the evaluation of variations on and combinations of the most effective treatments.

Substantial reductions in speeds were obtained by some of the treatments evaluated, for all three situations studied. There were also reductions in speed variance. These reductions are significant both in statistical and practical road safety terms.

For the village situation the most effective combination of treatments was the chicane without hatching, yellow or white transverse lines throughout the village, and countdown speed limit signs on the approach to the village.

For the bend treatments the most effective treatments were transverse lines with reducing spacing (including a central area filled with transverse lines); a central hatched area; a Wundt illusion (a series of chevrons with increasing angles but constant spacing, pointing towards the driver); and hatched areas at the edges of the road. Further speed reductions may be produced by combining one of the above treatments with the most effective sign treatments — SLOW or a triangular, warning sign style, advisory speed sign painted on the road surface.

For the general treatments all those which involved lane narrowing produced speeds significantly different from the control. Shoulders delineated by continuous lines were more effective, than those delineated by broken lines. Shoulder width was not important, but carriageway width was. For central hatching, type of delineation and width of hatched area was not important. The location (central/edge) and type (removing carriageway or lane space) of the narrowing was not important.

A SIMULATOR BASED EVALUATION OF SPEED REDUCTION MEASURES FOR RURAL ARTERIAL ROADS

1.INTRODUCTION — THE PROBLEM

This research aimed to investigate the effectiveness of a variety of treatments for reducing speeds on rural single-carriageway arterial roads, with the aim of identifying practical and cost effective measures to reduce both the frequency and severity of accidents on such roads. Such work is a crucial part of an overall safety strategy, since, according to the Gerondeau report (Commission of the European Communities, 1991), most fatal accidents in the European Union occur on the non-motorway rural road network. In Britain a growing proportion of accidents are taking place on rural arterials, often away from easily treatable blackspots. In 1993, rural A roads had the highest rate of involvement in fatal accidents of any category of road: 2.1 involvements in fatal accidents per 100 million vehicle kilometres, as compared to 0.6 on motorways and 1.5 on urban A roads (Department of Transport, 1994). At lower levels of severity (serious injury and slight injury accidents), other categories of road have higher involvement rates, indicating that the accidents occurring on these roads are far more likely to result in fatality. This phenomenon is connected both with the speed of travel (as compared with roads in urban areas or with non-A class rural roads) and with the lower standards of the roads as compared with motorways. There is considerable evidence that driving too fast for the conditions, rather than high speeds *per se*, is a major factor in accident causation. Indeed, in asurvey in 1993, only 7% of cars at twelve single carriageway A road sites exceeded the 60mph speed limit (Department of Transport, 1994). The varied geometry associated with rural A roads means that it is all too easy to drive at inappropriate speeds at some points, without actually breaking the speed limit.

In 1987 a national target of a one-third reduction in casualties by the year 2000 was set by the Department of Transport. The baseline for this target is the 1981-85 average. Comparing the 1993 statistics with this baseline, there has only been a 22% reduction in fatalities on rural A roads, while at the same time there has been an overall reduction of 32% in fatalities on all roads. Over the same period the total number of persons injured on rural A roads (predominantly car occupants) has actually risen by 4%, compared with an overall national reduction of 5%. The rural A roads are therefore responsible for an increasing share of casualties. This may well reflect the greater attention that has been devoted in recent years to the urban accident situation, as evidenced by the increasing resources for area-wide safety management and for traffic calming, particularly in residential areas. It is therefore considered appropriate to shift the focus somewhat in the direction of rural accident problems.

2.POTENTIAL SOLUTIONS

Taylor and Barker (1992) analyzed the British national injury accident database (STATS19) for injury accidents on single carriageway roads. The results demonstrated that accidents away from junctions account for the majority (61 percent) of accidents on rural, single-carriageway A roads. Of these non-junction accidents, 73 percent are of the following four types:

1.involving two vehicles on a two-lane road, at least one of which is “going ahead — other” (25 percent);

2.involving one vehicle on a two-lane road, which is “going ahead — other”, i.e. on a straight (18 percent);
3.involving two vehicles on a two-lane road, at least one of which is “going ahead on a bend” (12 percent);
4.involving one vehicle on a two-lane road, which is “going ahead on a bend” (18 percent).

These and other statistics from the study indicate that three principal types of accident predominate on rural arterial roads. Excessive speed is often a primary factor in all three types. They consist firstly of overtaking accidents, in which high speed variance leads to frequent overtaking, sometimes in inappropriate conditions. Secondly, there are loss of control accidents in which a vehicle travelling with excessive speed either strays into the opposing lane or runs off the road. The third type is when a driver travelling at high speed does not have time to take effective evasive action when he or she comes upon a pedestrian, a stationary or slow moving vehicle, or a vehicle making a turning manoeuvre across its path. This is due to a combination of the short sight distances common on this type of road and increased stopping distances due to high speeds. Many of this third type of accidents take place at junctions or in villages. At junctions these can generally be treated with a traditional “blackspot” approach, by using such remedial measures as dedicated turning lanes on the main road, or staggered junctions replacing crossroads. The other types of accident are harder to treat, but because of the importance of excessive speed some kind of traffic calming would seem to be appropriate.

This research, therefore, aimed to identify effective traffic calming measures that:

1.reduce curve entry speeds for sharp bends;
2.reduce speed, speed variance and/or overtaking on relatively straight sections of road;
3. reduce speeds on the approach to and through villages.

There are, in theory, a wide range of potential solutions to these accidents. Enforcement could be stepped up, but this would be costly and it would be hard, if not impossible, to cover all the relevant stretches of road, since these non-junction accidents are, by their very nature, scattered. It is also not necessarily the case that these accidents involve drivers breaking the speed limit. Alternatively, traffic calming techniques that have been developed for urban areas could be transferred to these rural roads. These techniques often involve vertical deflection e.g. road humps. Such methods have been tried in the UK, but have generally not been popular because they have the potential to cause extra accidents. For example, Hampshire County Council introduced speed humps on single-carriageway roads in the New Forest in an attempt to reduce collisions with animals, but removed the speed humps after a fatal accident in which a high-speed vehicle lost control going over a hump.

The project approach has therefore been to test a variety of solutions that do not involve radical deflection of the vehicle and which are also low cost. The techniques used were chosen following a review of the literature (Pyne, 1995). For all three situations they consisted of:

1.various module lengths and mark gap ratios for edge and centre lines;
2.narrowing carriageway or removing lane space from the edge and/or centre of the road;
3.using trees to create an illusion of narrowing.

Further techniques used for the villages and bends only were:

4.various delineation techniques;
5.various signs on posts and/or on the road surface;
6.transverse lines with reducing spacing on the road surface to create an illusion of acceleration;
7.Wundt illusion to create an illusion of narrowing (Shinar, 1974).

Certain treatments were not evaluated because of the limitations of the driving simulator at the time e.g. treatments using kerbs or vertical deflection (including speed humps, rumble strips, variations in road surface texture). The simulator is now able to simulate kerbs, but being static may not be suitable for the simulation of vertical deflection.

Many of the techniques tested are, it might be argued, fairly well established, but there has been little scientific evaluation of their effectiveness in altering behaviour or improving safety. For example as regards centre-line markings, the OECD report on behavioural adaptation found that the information on safety benefits was very mixed, and the information on behavioural effects was virtually non-existent (OECD, 1990). Some of the techniques for reducing speed on the approach to villages were evaluated in a recent study by the Transport Research Laboratory (Wheeler *et. al.*, 1993), but they were only evaluated in various combinations and in a variety of different situations which makes it difficult to draw conclusions about the effectiveness of the treatments.

3.EXPERIMENTAL DESIGN

3.1THE DRIVING SIMULATOR

The experimental approach has been the use of the Advanced Driving Simulator at the University of Leeds (for detailed description see Carsten and Gallimore, 1993). This facility is a sophisticated, static-base simulator built around a Silicon Graphics Reality Engine workstation. The “driver” sits in a complete car, with all the basic controls and dashboard indicators fully operational. The car is situated directly in front of a projection screen with the driver's seat aligned with a video projector. The workstation continuously receives information on driver activation of the vehicle controls and re-calculates the vehicle position using a complex vehicle handling model. The current position is continuously passed to the visualisation software, which calculates the resulting driver view and projects it onto the screen in front of the car. All this takes place in real time to provide smoothly flowing images.

The simulator allows investigations to be carried out in a controlled laboratory environment. The roadway and traffic environment can be fully controlled, so that, apart from the treatment being tested, subjects experience the same conditions in all the tests. Thus the internal validity of the research is increased. In addition, the simulator permits investigations of novel and/or expensive treatments which it is not appropriate or legal to test on real roads. expensive to do so.

In terms of the external validity of the research, studies of speeds adopted in other driving simulators have suggested that they are valid in at least relative terms. Some studies have indicated, however, that speeds are consistently higher in absolute terms, compared to speeds which would be adopted in a corresponding real world situation (Blaauw, 1982 and Riemersma, 1990). In order to investigate this question for the simulator used in this research, a real road was simulated and the speeds of subjects on the simulated road were compared to speeds of subjects and other drivers on the real road (see section 9).

3.2 THE SIMULATED ROADS — PHASE ONE

The aim of phase one was to indicate the effectiveness of each individual measure.
Three different stretches of simulated, idealised road, or base road section, were created. These corresponded to the three situations of interest (sharp bends, villages, relatively straight sections). These base road sections consisted of a length of road without road markings or signs to which a variety of treatments such as road markings or signs are applied to form a treated road section. The base road sections are illustrated in Figure 1.1.

The base road sections were experienced a number of times by the subjects, each time with a different speed reducing measure added. There were twenty six different treatments (including the control) on the curves. These consisted of fourteen on left-hand curves only, eight on right-hand curves only and four on both (i.e. thirty treated sections in total). There were eighteen different treatments for the villages and ten general treatments for the fairly straight sections. The treatments are described in Appendix 1, including illustrations (Figures 1.2 to 1.6) for the treatments for which a written description is not adequate.

The base road section which was used to investigate treatments on the approach to sharp bends, consisted of an 800m straight, followed by a 200m long curve of 300m radius to the left or right i.e. each base road section was 1km long.

The base road section which was used to investigate treatments on the approach to villages, consisted of a 400m straight, followed by a 200m long curve of 800m radius, followed by another 400m straight, and finally a 400m long "village" i.e. each section was 1.4km long.

The base road section which was used to investigate treatments on relatively straight sections (general treatments), consisted of a 800m straight followed by a treated gently curving part consisting of nine 100m long left-hand curves of progressively larger radius (1000m then increasing in radius by steps of 700m up to a curve of 6600m radius). This part was then repeated in order to study the effect of the treatment on overtaking, but this time using curves to the right. Thus this section was 2.6km long.

The first 300m of the gently curving part of the section was used to study the effect on speed of the treatment. The overtaking study involved the introduction of a new HGV at the beginning of the second gently curving part of each section. If at the end of this gently curving part of the section the subject had not overtaken the HGV, the HGV left the road along a fork to the left. The position of the car when it overtook the HGV (if it did at all) indicated the magnitude of the deterrence effect of the given treatment, because conditions for overtaking (i.e. sight distance) improve progressively over the length of that part of the section.

The last part of each complete section (i.e. the 200m bend, the 400m village or 2x900m gently curving part) was treated. The other parts of the section (e.g. the 800m straight for the bends and general treatments) were untreated for all or most of its length. Some did have transitional treatment on the immediate approach to the treated part (e.g. progressive narrowing). The purpose of the untreated and transitional parts of each section, was to allow the subjects to reach their desired speed between the treated parts of sections.

There were three groups of subjects. One group of seventeen subjects experienced the curve treatments, another group of eighteen subjects experienced the village treatments, and a third group of nineteen subjects experienced the general treatments. The characteristics of the subjects are discussed in section 5.

The treated road sections were mixed randomly and placed end to end to form a continuous road or block. In order to negate the fact that driving behaviour was likely to change as the subject became increasingly used to the simulator, and increasingly fatigued, three blocks were created each containing all the treatments, including the control, but in a different order. In this way each measure was experienced three times, the mean position of each measure being roughly in the middle of the block. The mean of the three values for each dependent variable was used in the analysis. The blocks were not in the same order for all the subjects; all six different permutations were used.

At the beginning of each block a practice stretch of road was included, so that the subjects could get used to the simulator again and, in the case of the first block, to the type of road they were going to be driving on. This practice stretch of road consisted of one left and one right-hand curve section, or two village sections or one general treatments section, as appropriate. The road sections in the practice stretch had road markings and signs which were the same as those for the control section.

In order to create a realistic situation with regard to the presence of oncoming traffic, subjects met vehicles coming in the opposite direction at a different point on the untreated part of each section for all three types of road section. For the general treatments experiments, two extra “dud” sections were added to each block, the results of which were not used, and on the treated part of these the subject met a vehicle coming in the opposite direction. Care was taken to ensure that the dud sections were treated with measures that had already been experienced. Oncoming vehicles were not introduced on the treated parts of sections, since they would be likely to affect the behaviour of the driver.

The total length of the blocks was therefore as follows:

Curves:1km x (2 practice sections + 30 treated sections) = 32km
Villages:1.4km x (2 practice sections + 18 treated sections) = 28km
General:2.6km x (1 practice + 10 treated sections + 2 duds) = 33.8km

Before experiencing any of the experimental blocks, each subject drove on a practice road until he/she felt confident with driving on the simulator.

3.3THE SIMULATED ROADS — PHASE TWO

The aim of the second round of experiments was to evaluate some combinations of treatments, to evaluate variations on some of the treatments, and to evaluate some of the bend treatments on a wider range of curve radii.

In phase two there were two types of road instead of three: one for villages; and one for bends and general treatments. The bends and general treatments were combined to provide a more varied road and to enable most of the bend treatments to be applied to the same direction bend. There was one group of eighteen subjects, made up from those who did the villages and bends in phase one, i.e. those not involved in the validation study. Each subject came for two, two-hour sessions on different days, and experienced the bends and general treatments in the first session and the villages in the second session.

On the bends and general road there were eleven general treatments and twenty-two bend treatments combined in one block (thirty three treatments in total). No duds were included in phase two, because subjects were meeting oncoming vehicles more frequently because of the inclusion of the shorter bend sections. Otherwise, oncoming vehicles were as before. All general treatments were on right-hand bends, as were three of the bend treatments (fourteen in total).
The other nineteen bend treatments were on left-hand bends. The treatments are described in Appendix 1.

The bends base road section was the same as in phase one. The general base road section consisted of just the first four 100m right-hand curves, data being collected on the first 300m as in phase one. Overtaking behaviour was not investigated in phase two, because of restrictions in time and finance.

The blocks were created as before, i.e. all the general and bend sections were mixed randomly to make the first block and then rearranged to make two further blocks as in phase one. As in phase one, each block started with practice sections treated as controls, in this case, one left and one right-hand 300m radius bends section and two general sections.

The villages base road section was exactly as in phase one. The blocks were created in the same way as before and the practice sections and oncoming traffic were the same as before.

4. DATA COLLECTED

Speed was measured in miles per hour (mph). Lateral position was represented by the distance in metres of the centre of gravity of the car from the centre of the carriageway, being positive on the normal (left) side of the carriageway and negative on the opposite side. For the general treatments, speed and lateral position were measured at 5m intervals over a 300m section (i.e. 60 values). Table 1 lists the raw data that was collected.

Table 1.1: Data collected from the simulator

Villages. Speed at beginning of village (A). Speed at middle of village (B). Speed at end of village (C).	**General.** Mean of 60 speed values. Mean of 60 lateral position values.
Bends. Speed at curve entry point (X). Speed at curve mid-point (Y). Speed at end of curve (Z).	 Lateral position at curve entry point . Lateral position at curve mid-point. Lateral position at end of curve.

5.THE SUBJECTS

5.1.THE SUBJECTS — PHASE ONE

There were three groups of subjects. One group of 17 subjects experienced the curve treatments, another group of 18 subjects experienced the village treatments, and a third group of 19 subjects experienced the general treatments. No attempt was made to obtain a sample which was representative of the type of people who use the type of road of interest. The sample was, however, roughly stratified by age and sex. The subjects were paid £10 per session.

The subjects were selected from respondents to an advertisement in a local newspaper. The respondents were asked a short questionnaire to help with subject selection and find out when they were available. A longer questionnaire (see Appendix 2) was completed by each subject after they had used the simulator, the results of which are summarised below.

Appendix 3 consists of frequency tables for selected variables and Appendix 4 consists of two way cross-tabulations of sex by age group and three way cross-tabulations of age group, by selected variables, by sex.

It can be seen from the tables that in each group approximately one quarter were male and under thirty; one quarter male and over thirty; one quarter female and under thirty; and one quarter female and over thirty.

In the bends group, two subjects had been driving for less than a year. In the villages and general group all the subjects had been driving for more than a year. The number of subjects who had been driving regularly for less than five years was two for the village group, five for the bends group and four for the general group.

The number of driving tests taken ranged from one to three, except for one subject from the general group who had taken five tests.

Most subjects had not taken further driving courses. In total, two had taken the instructors test; two had taken the advanced driving test; two had taken the police test; two had taken a test for tracked vehicles (army); two had taken the motorcycle test; three had taken a HGV and/PSV test; one had taken a taxi driver's course and one a course in driving a minibus. Any given subject may have taken more than one of these tests.

None of the subjects in the general group had penalty points, since most of these also took part in the validation study and it was necessary that they should not have points, in order that they could drive the real car. Five of the subjects in the villages group and three in the bends group had points. In the bends group none of the women had penalty points.

In the villages group 44.4% of the subjects did less than ten thousand miles in the last year. The corresponding figure for the bends group was 58.0%. For the general group it was 26.3%. This was the modal class for the villages and bends groups, but for the general group it was the ten thousand to nineteen thousand class. Only one women (in the general group) and only one of the young men (in the villages group) did 20,000 miles or more.

In the villages and general groups all the subjects except one had driven at least several times a week. In the bends group all the subjects had driven at least this often. The percentages of subjects driving on *rural* roads at least this often were 61% for the villages group, 47% for the bends group, and 68% for the general group. In the general group all the men drove daily.

About half of the subjects drove as part of a job. Thirty-three percent of the subjects in the villages group; 47% of the bends group subjects and 53% of the subjects in the general group drove as part of a job. In the bends group none of the women drove as part of a job more often than several times a month monthly.

5.2.THE SUBJECTS — PHASE TWO

There was one group of eighteen subjects, made up from those who did the villages and bends in phase one, i.e. those not involved in the validation study. Each subject came for two, two-hour sessions on different days, and experienced the bends and general treatments in the first session and the villages in the second session. The results for one of the subjects for the villages were not used since he drove at 100 mph throughout, which was far faster than he had driven in phase one, and far faster than any of the other subjects. It was considered that he was not behaving in a normal manner. Thus there were only seventeen cases for the village treatments.

Frequency tables for selected variables are presented in Appendix 5 and two way cross-tabulations of sex by age group and three way cross-tabulations of age group, by selected variables, by sex are presented in Appendix 6.

It can be seen from the tables that, as in phase one, approximately one quarter were male and under thirty; one quarter male and thirty or over; one quarter female and under thirty; and one quarter female and thirty or over.

Four of the subjects had been driving for less than five years. These were all under thirty, three were female and one was male. Of these one (a male) had been driving for less than one year. The number of driving tests taken ranged from one to three. Only four of the subjects, one female and three males had taken as many as three tests. Only four of the subjects (one female and three males) had taken additional driving courses, one of these having taken the instructors test, two the motorcycle test, and one some other type of course. One third of the subjects had current penalty points (one female and five males).

Half the subjects drove less than ten thousand miles over the last year. A further third drove between ten and nineteen thousand miles. All those who had driven twenty thousand miles or more were male. Nearly two thirds of the subjects had driven daily over the last year, while a further third had driven several times a week. A third had driven daily on rural roads (one female and five males), a further fifth several times a week, and a further third several times a month. Two of the subjects had driven on this type of road less often than monthly. Half the subjects never drove as part of a job (five females and four males).

6. EVALUATION

6.1.DESCRIPTIVE STATISTICS

The underlying aim of this research was to find ways of reducing accidents on rural arterial roads. The assumption is made that there is a relationship between *excessive or inappropriate* speeds and accidents. There are many other factors which contribute to accident causation and it cannot be assumed that reducing speeds will necessarily reduce accidents, as the driving conditions, and the resulting difficulty of the driving task, must also be taken into account. Garber and Gadiraju (1989) found that accidents did not necessarily increase as mean speeds increased, and that drivers tend to adopt a speed which is appropriate to the conditions as they perceive them, regardless of the speed limit. It is not clear from the research which characteristics of the speed distribution are most predictive of accident numbers or severity. This may be due to the fact that it depends on the nature of the road and the accident problem. Many studies have suggested that speed variance is correlated to accident involvement (e.g. Munden, 1967; Hauer, 1971; West and Dunn, 1971; and Garber and Gadiraju, 1989). Explanations for this relationship include the higher involvement in overtaking manoeuvres (either active or passive) by the fastest and slowest drivers, and/or the general characteristics of such drivers. Speed variance may therefore be important on relatively straight stretches of road, where overtaking accidents are a problem. The relative speed of the accident involved vehicles is also important in accident severity. The fact that the severity of accidents increases with the speed of the accident involved vehicle, reducing the speed of the fastest drivers is also important. Hence the 85th percentile speed is of interest. Reducing the speed of the fastest drivers may also reduce certain types of accidents, such as loss of control accidents on bends, accidents in villages or at junctions where there are pedestrians, parked or manoeuvring vehicles. It is reducing the speed of the fastest drivers which is likely to improve the general feeling of safety in villages. Several studies have tried to demonstrate or quantify the relationship between mean speed and accidents, but the evidence is not as strong as for speed variance. The simplest statistical model, according to Finch *et al.* (1994) in their review of the literature, is that for a 1mph reduction in mean speed there is a 5% reduction in accidents. The skewness of the speed distribution has also been put forward as being related to accident levels.

Bearing in mind the potential importance of various aspects of the speed distribution, several dependent variables were calculated in the form of descriptive statistics (e.g. mean, variance, 85th percentile) of the raw data for each treatment. Ranks were also calculated for each of these secondary variables for each treatment, and several overall scores were calculated by adding the ranks for that treatment, for some important combinations of variables. The ranks were calculated so that a rank of one is most desirable, and a high rank is least desirable, so that a low score indicates an effective treatments. These scores allow the treatments to be assessed in different ways according to the value placed on a given aspect of the speed distribution. In fact many of these statistics (e.g. speed variance, mean speed, 85th percentile speed, skewness and also design speed) have been found to be correlated to each other (Garber and Gadiraju, 1989). This was also the case in this study. A key to the variable names can be found in Appendix 4. Tables 5.1 to 5.15 in Appendix 5 show the values and ranks of each of the secondary variables for each treatment and Table 2 defines the scores.

A successful village treatment is considered to be one which produces a low speed at the beginning of the village and maintains a low speed throughout the village. Thus speeds at A, B and C are considered. The 85th percentile speed (V85) is considered as well as mean speed because it indicates the effect of the treatment on the speed of the fastest drivers. A low speed variance, however, may also be desirable because of the link between high speed variance and increased frequency of overtaking.

A successful bend treatment is considered to be one which produces a low curve entry speed. Again, V85 is considered as well as mean speed. A small range of lateral position between the three points studied is also desirable, if loss-of-control accidents and head-on collisions are to be avoided.

A successful general treatment for relatively straight sections of road is considered to be one which reduces speed variance and the V85, as well as the mean speed, because of the wish to reduce overtaking and the speeds of the fastest drivers. Another factor to consider is the effect on lateral position, a shift towards the centre line being, in many circumstances, undesirable.

Table 2.1: Definitions of scores

SCORE NAME	DEFINITION
VILLA1, VILLB1, VILLC1	Sum of ranks of: mean speed, 85th percentile speed, speed variance — at points A, B or C in village.
VILLA2, VILLB2, VILLC2	Sum of ranks of: mean speed, 85th percentile speed — at points A, B, or C in village.
BENDS1	Sum of ranks of: mean speed, 85th percentile speed, speed variance — at curve entry point, X
BENDS2	Sum of ranks of: mean speed, 85th percentile speed, range of lateral position — at curve entry point, X
BENDS3	Sum of ranks of: mean speed, 85th percentile speed — at curve entry point X.
GENERL1	Sum of ranks of: mean speed, 85th percentile speed, speed variance, mean of lateral position — for mean of 60 values.
GENERL2	Sum of ranks of: mean speed, 85th percentile speed, speed variance — for mean of 60 values.
GENERL3	Sum of ranks of: mean speed, 85th percentile speed, mean of lateral position — for mean of 60 values.
GENERL4	Sum of ranks of: mean speed, 85th percentile speed — for mean of 60 values.

6.2.WILCOXON MATCHED-PAIRS SIGNED RANKS TEST

Wilcoxon matched-pairs signed ranks tests were carried out on the raw speed and lateral position data for pairs of treatments. It was decided that a non-parametric test should be used because of the small sample sizes, and the fact that speed data is not always normally distributed, nor was it expected that the different treatments would produce homogeneous variances. Indeed the variation in skewness and variance of the data for the different treatments is of interest, since both speed variance and skewness of the speed distribution have been proposed as indicators of road safety. Using a non-parametric test also reduces the probability of making a Type I error, i.e. rejecting a true null hypothesis, and increases the probability of making a Type II error i.e. accepting a false null hypothesis. It was considered that this cautious approach was better than the converse, which is the case for parametric tests such as analysis of variance. In addition two-sample parametric tests analyse differences between means, with the assumption that the other characteristics of the distribution should be similar. Non-parametric tests on the other hand do not just measure differences between the means, which is more appropriate in this study since other characteristics of the distribution are of interest as well as the mean speed.

Wilcoxon matched-pairs signed ranks tests were carried out between each treatment and the appropriate control. The results of these tests are shown in Tables 6.1 to 6.6 in Appendix 6. Further tests were carried out between other pairs of treatments which were of interest. The results of these tests are included in the text. Care has to be taken when making multiple comparisons using such tests because there can be a build up of errors. For this reason, in the discussion below, most comparisons are between two (i.e. one pair) or occasionally three treatments (i.e. three pairs).

7. DISCUSSION OF RESULTS

7.1. VILLAGE TREATMENTS — PHASE ONE

The relative effectiveness of the village treatments will be discussed in terms of the effect on the various aspects of the speed distribution, and the relative effectiveness at different points through the village.

Tables 3.1 to 3.3 show the range of change obtained, relative to the control, for various aspects of the distribution of speeds — at the beginning, middle and end of the village. The percentage reduction is also given (in brackets next to the absolute reduction). In addition, these tables show the lowest and highest values obtained for a given statistic, and the value obtained for the control situation, from which the range of change was calculated. The number of the treatment which produced each value is given next to it in brackets.

Table 3.1: Range of change in speed, at the beginning of the village (A), for phase one village treatments.

At beginning of village (A)	Lowest speed in mph (treatment)	Highest speed in mph (treatment)	Control speed in mph	Range of change in mph
Mean speed	30.69 (V1.06)	34.18 (V1.14)	32.95	–2.26 (–6.9%) to +1.23
85th %ile speed	36.88 (V1.06)	42.06 (V1.09)	39.92	–3.04 (–7.6%) to +2.14
Speed variance	16.99 (V1.18)	34.04 (V1.15)	28.61	–11.62 (–40.6%) to +5.43

Table 3.2: Range of change in speed, at the middle of the village (B), for phase one village treatments.

At middle of village (B)	Lowest speed in mph (treatment)	Highest speed in mph (treatment)	Control speed in mph	Range of change (mph)
Mean speed	31.05 (V1.10)	32.75 (V1.05)	32.43	–1.38 (–4.3%) to +0.32
85th %ile speed	35.60 (V1.18)	39.97 (V1.09)	38.37	–2.77 (–7.2%) to +1.60
Speed variance	17.94 (V1.05)	30.47 (V1.04)	25.29	–7.35 (–29.1%) to +5.18

Table 3.3: Range of change in speed, at the end of the village (C), for phase one village treatments.

At end village (C)	Lowest speed in mph (treatment)	Highest speed in mph (treatment)	Control speed in mph	Range of change (mph)
Mean speed	33.07 (V1.10)	34.76 (V1.04)	34.71	–1.67 (–4.8%) to +0.05
85th %ile speed	33.07 (V1.10)	47.40 (V1.04)	42.43	–9.36 (–22.1%)to +4.97
Speed variance	16.77 (V1.08)	55.52 (V1.04)	40.37	–23.60 (–58.5%) to +5.15

It can be seen that changes in both mean speed and V85 were small at all three points. This was probably in part the result of subjects driving more slowly than they normally would. Even such speed reductions, however, are worth realising in terms of improvements in safety, since even a 1mph reduction in mean speed has been shown to produce significant safety benefits (Finch *et al.*, 1994). Although it is difficult to predict the magnitude of any speed reduction produced by the measures on a real road, it is reasonable to make conclusions about the relative effectiveness of the different treatments.

As mentioned above overall scores were calculated for each treatment by adding the ranks for that treatment, for some important combinations of variables. The ranks were calculated so that a rank of one is most desirable, and a high rank least desirable, therefore a low score indicates an effective treatment.

At the *start of the village* (A) the most effective treatments when the ranks of mean speed and V85 were considered (VILLA1 score, Table 8.4), were transverse lines with a score of 2; Wundt illusion (5); countdown speed signs (6); central hatching with no road narrows sign (13); chicane (15); and the speed limit on the road surface (also with a score of 15).

At the *middle of the village* (B) when the ranks of mean speed and V85 were considered the most effective treatments were central hatching with a road narrows sign with a score (VILLB1) of 3; central transverse lines (5); countdown speed limit signs (3); central hatching without a road narrows sign (7); the chicane (11); and the transverse lines (13).

At the *end of the village* (C), when the ranks of mean speed and V85 were considered, the most effective treatments were central hatching with a sign with a score (VILLC1) of 2; the central transverse lines (4); the street lights (7); the central hatching without a sign (9); the count down speed limit signs (11); and the chicane (14).

Table 9.01 shows the results of the Wilcoxcon matched-pairs signed ranks test for the phase one village treatments. Of the phase one treatments, only the transverse lines produced speeds significantly different from that of the control at the start of the village. The central hatching without a road narrows sign was the only treatment to produce such a result in the middle of the village. At the end of the village it was the central hatching *with* a road narrows sign which produced the only significant result.

Although the only treatments to produce significantly different speeds from the control were transverse lines at A, and central hatching at B and C, several other treatments were considered to be worthy of further investigation. These are the countdown speed limit signs which produced some of the best speeds at all three points; the chicane and central transverse lines which were reasonable at B and C; the speed limit on the road surface and the Wundt illusion which were reasonable at A; plus the hazard marker posts which produced good speed variances at A and C.

7.2.VILLAGE TREATMENTS — PHASE TWO

Tables 3.4 to 3.6 show the range of the change obtained for various aspects of the distribution of speeds relative to the control. The results for one of the subjects for the villages were not used since he drove at 100mph throughout, which was far faster than he had driven in phase one, and far faster than any of the other subjects. It was considered that he was not behaving in a normal manner. Thus there were only seventeen cases for the village treatments.

Table 3.4: Range of change in speed, at the beginning of the village (A), for phase two village treatments.

At beginning of village (A)	Lowest speed in mph (treatment)	Highest speed in mph (treatment)	Control speed in mph	Range of change (mph)
Mean speed	28.56 (V2.19)	31.66 (V2.7)	32.80	–4.24 (–12.9%) to –1.14
85th %ile speed	34.28 (V2.20)	38.63 (V2.20)	41.48	–7.20 (–17.4%) to –2.85
Speed variance	21.95 (V2.02)	46.06 (V2.02)	67.53	–45.58 (–67.5%) to –21.47

Table 3.5: Range of change in speed, at the middle of the village (B), for phase two village treatments.

At middle of village (B)	Lowest speed in mph (treatment)	Highest speed in mph (treatment)	Control speed in mph	Range of change (mph)
Mean speed	28.85 (V2.17)	31.35 (V2.10)	31.80	–2.95 (–9.3%) to +0.45
85th %ile speed	33.74 (V2.11)	38.84 (V2.02)	37.79	–4.05 (–10.7%) to +1.05
Speed variance	18.83 (V2.05)	32.24 (V2.02)	48.25	–29.42 (–61.0%) to –16.01

Table 3.6: Range of change in speed, at the end of the village (C), for phase two village treatments.

At end village (C)	Lowest speed in mph (treatment)	Highest speed in mph (treatment)	Control speed in mph	Range of change (mph)
Mean speed	30.00 (V2.17)	32.82 (V2.05)	33.38	–3.38 (10.1%) to –0.56
85th %ile speed	35.32 (V2.17)	44.04 (V2.10)	42.05	–6.73 (–16.0%) to +1.99
Speed variance	32.07 (V2.13)	72.11 (V2.09)	62.74	–30.67 (–48.9%) to +9.37

The size of the maximum reduction in mean speed was higher for the phase two treatments than for the phase one treatments. The maximum reduction in V85 was higher than in phase one at points A and B, but not at point C. The maximum reduction in speed variance was much higher in phase two especially at points A and B.

At the *start of the village*, when considering the ranks of mean speed and V85 (VILLA1 score, Table 8.5), the most effective treatments were: the chicane + the transverse lines + countdown speed limit signs + the speed limit on the road surface + the hazard marker posts or HMPs (V2.19); the transverse lines + countdown speed limit signs + the speed limit on the road surface + the HMPs (V2.20); the chicane + transverse lines + countdown speed limit signs (V2.17), all three of which produced a score of 4. These were followed by the yellow transverse lines through the village (V2.11) with a score of 8 and the chicane + transverse lines + HMPs (V2.16) with a score of 10.

At the *middle of the village*, the most effective treatments were: the yellow transverse lines through the village (V2.11); and the chicane + the transverse lines + countdown speed limit signs + the speed limit on the road surface + the HMPs (V2.19), both with a score (VILLB1) of 4. Next were the chicane + transverse lines + countdown speed limit signs (V2.17) with a score of 6; the chicane + transverse lines (V2.15) with a score of 7 and the chicane + transverse lines + speed limit on the road surface (V2.18) with a score of 10.

At the *end of the village* the most effective treatment was the chicane + transverse lines + countdown speed limit signs (V2.17) with a score (VILLC1) of 2. This was followed by the chicane + transverse lines + HMPs (V2.16); and the Wundt illusion + countdown speed limit signs + the speed limit on the road surface + the HMPs (V2.21), both with a score of 6; and the chicane + transverse lines + speed limit on the road surface (V2.18) with a score of 8.

Tables 9.02 and 9.03 show the results of the Wilcoxcon matched-pairs signed ranks test for the phase two village treatments.

The hazard marker posts (V2.03) did not have a significant effect on speed at any of the three points, neither did the speed limit on the road surface (V2.05). The combination of countdown speed signs and the speed limit on the road surface was effective at the start of the village, but it did not maintain low speeds throughout the village. The additional value of the speed limit on the road surface is not conclusive, since there was no significant difference in speeds between the countdown speed limits on their own (V2.04) and in combination (V2.06).

At all three points the chicane without hatching (V2.08) produced speeds significantly different from the control, but the chicane with hatching (V2.07) did not. This is probably because the route of the lane was less obvious without hatching. The chicane with hatching was perhaps more similar to the kerbed chicanes found in some villages. However, a kerbed chicane would probably make the route of the lane more obvious than the unhatched chicane used here and perhaps increase speeds. If no kerbs were used the practitioner would have to be convinced that the central area was sufficiently clearly defined (e.g. by contrasting road surface) as to avoid driver confusion. It may be the case, however, that improved definition would result in higher speeds, just as hatching did. This warrants further investigation. The unhatched chicane was used in this experiment because the simulator could not produce kerbs and contrasting road surfaces, and the combination of a hatched chicane and transverse lines was considered to be too "busy" and expensive in terms of paint. At point A, but not points B or C, there was a significant difference between the speeds produced by the chicane with hatching and the chicane without hatching.

The chicane without hatching (V2.08) and the yellow transverse lines through the village (V2.11) remained effective at B and C both as individual treatments and in combination. The only signs worth adding to the chicane and transverse line combination (V2.15) are countdown speed limit signs (V2.17) as these produced a significant effect at C relative to just the chicane and transverse lines (V2.15). The addition of other signs in treatments V2.16, V2.18 and V2.19 did not produce speeds significantly different from V2.15 at points A, B or C.

At all three points the combination of unhatched chicane and yellow transverse lines through the village (V2.15) did not produce significantly different speeds from the chicane (V2.08) on its own or from the transverse lines (V2.11) on their own. It may not, therefore, be worth the expense of installing the chicane as well as the transverse lines. It may be that a combination of transverse lines and central hatching would have been more effective.

The colour of the transverse lines appears not to be important since there was no significant difference between treatments V2.09 and V2.10 at any of the points. The extent of the transverse lines is important, since it was only treatment V2.11, in which the transverse lines extended through the village, which produced speeds significantly different from the control at all three points. Treatments V2.11 also produced significantly different speeds from V2.09 and V2.10. It is also worth noting that the transverse lines, as simulated, did not have a vertical dimension — they relied purely on affecting the visual, rather than the auditory sense, and yet they were still effective. The aesthetic aspects of transverse lines has to be considered especially if they are to be installed all the way through the village. Transverse lines have been found to be effective at reducing speeds and accidents on both the approach to roundabouts and bends (Denton, 1973; Helliar-Symons, 1981; and Maroney and Dewar, 1987). Evidence as to the persistence of effects over time is less conclusive. This needs to be studied in real world trials.

As an individual treatment the Wundt illusion was effective at the beginning of the village, but not at the middle or end. It was only effective here if it extended through the village (V2.14). The colour of the paint appears not to matter as there was no significant difference between treatments V2.12 and V2.13 at any of the points. In fact there was no significant difference between any pair of Wundt illusion treatments. The Wundt illusion was effective at the end of the village, however, when combined with various signs (V2.21). It would be better to install transverse lines rather than the Wundt illusion, since they were more effective.

At points A and B, removing the chicane from the treatment which included the most treatments (V2.19) did not result in significantly different speeds (V2.19 vs. V2.20), but replacing the transverse lines with the Wundt illusion did (V2.19 vs. V2.21). This suggests that at the start and middle of the village the transverse lines are a vital component. At point C treatment V2.19 was not significantly different from either V2.21 or V2.20.

In summary, the results suggest that the combination of the chicane without hatching, yellow or white transverse lines throughout the village and countdown speed limits would be the most effective combination of the treatments evaluated for villages. Further simulator and real-world trials to confirm this and evaluate a combination with central hatching or central island, instead of the chicane, would be of value.

7.3.BEND TREATMENTS — PHASE ONE

Table 3.7 shows the range of the change obtained for various aspects of the distribution of speeds relative to control at the curve entry point, for the non-sign bend treatments.

Table 3.7: Range of change in speed, for non-sign bend treatments.

Non-sign treatments	Lowest speed in mph (treatment)	Highest speed in mph (treatment)	Control speed in mph	Range of change (mph)
Mean speed	40.19 (B1.10)	45.41 (B1.03)	43.86	–3.67 (–8.4%) to +1.55
85th %ile speed	48.92 (B1.10)	55.24 (B1.04)	56.04	–7.12 (–12.7%) to –0.80
Speed variance	49.58 (B1.15)	73.18 (B1.08)	68.03	–18.45 (–27.1%) to +5.15

The percentage maximum reduction in mean speed was not particularly high. It lies between those obtained for the phase one village treatments and those obtained for the phase two village treatments. However, V85 is a more important statistic for bends given that it is the drivers travelling at the highest speeds who are most likely to loose control. A reduction of 7 mph in the V85 could have an important effect on safety on sharp bends.

At the curve entry point, when the ranks of mean speed and V85 are considered (BENDS3 score, Table 8.11), the most effective non-sign treatments were the transverse lines to the curve mid-point (B1.10) and to the curve entry point (B1.11) with a score of 2 and 5 respectively. These were followed by the Wundt illusion (B1.14) and the 1.35m hatching at the edges (B1.15), both with a score of 8; and the central transverse lines (B1.12) and central hatching (B1.13), both with a score of 13.

Tables 9.04 to 9.06 show the results of the Wilcoxcon matched-pairs signed ranks test for the phase one bend treatments. Treatments B1.10 to B1.15 inclusive produced significant results, that is all the treatments involving transverse lines, central hatching, the Wundt illusion, and the hatching at the edges of the road. Variations in edge and centre lining; hazard marker posts; trees at the roadside; and the other variations on narrowing (both at the edges and centre) did not produce speeds significantly different from the control. At the curve entry point, out of treatments B1.11 to B1.15, only the hatched shoulders (B1.15) produced speeds significantly different from (higher than) the transverse lines to the curve mid-point (B1.10) (p=0.0395). At the curve mid-point, only the full-width transverse lines (B1.10 and B1.11) and the Wundt illusion produced a significant result. At the end of the curve, it was the transverse lines which extended as far as the curve mid-point (B1.10), the central hatching, the Wundt illusion, and the hatching at the edges of the road which produced a significant result. The nearside shoulder also produced a significant result at the end of the bend but not at the other two points. The range of lateral position was not affected significantly by any of the treatments.

The central hatching and central transverse lines involve narrowing by removing lane space from the centre of the carriageway. The hatched shoulders involve narrowing by removing lane space from the edge of the carriageway. The transverse lines and Wundt illusion do not involve narrowing. Narrowing should only be used in situations where the carriageway is wide, since it forces vehicles towards the centre or edge of the road. In situations where there is a large number of pedestrians and/or cyclists, who can make use of the road space, a pavement and or cycle lane/track may be an appropriate variation on hatched shoulders. Narrowing by removing lane space from the centre of the carriageway may increase the danger to vulnerable road users since it forces vehicles towards the edge of the road. The absolute and relative frequency of head-on collisions and loss-of-control accidents should also be considered which deciding whether to remove lane space from the middle or edge of the road, or not at all. There was no significant difference between the speeds produced by the central hatching and the central transverse lines. Therefore, since the latter is likely to be more expensive to install, the former would be most practical in situations where central narrowing is appropriate.

The treatments which were tested on right-hand bends were mainly signs, plus some of the treatments also used on left-hand bends to facilitate comparison between the effect of treatments on behaviour on left and right-hand bends.

Table 3.8 shows the range of the change obtained for various aspects of the distribution of speeds relative to control at the curve entry point, for the bend treatments which used signs.

Table 3.8: Range of change in speed, for sign bend treatments.

Sign treatments	Lowest speed in mph (treatment)	Highest speed in mph (treatment)	Control speed in mph	Range of change (mph)
Mean speed	40.03 (B1.24)	45.28 (B1.20)	43.30	–3.27 (–7.6%) to +1.98
85th %ile speed	47.61 (B1.27)	56.49 (B1.20)	50.70	–3.09 (–6.1%) to +5.79
Speed variance	37.56 (B1.27)	64.82 (B1.20)	42.01	–4.45 (–10.6%)to +22.81

The maximum reduction in all three statistics was lower for the sign treatments than for the non-sign treatments. The maximum reduction in the V85 was especially unimpressive. At the curve entry point, when the ranks of mean speed and V85 are considered (BENDS3 score, Table 8.11), the most effective sign treatments were SLOW on the road surface, with a score of 4; the triangular speed sign on the road surface, with a score of 5; the REDUCE SPEED NOW plate, with a score of 6.

At this point, all the *signs* produced speeds significantly different from those of the right-hand bend control, except the bend warning sign on the road surface and the combination of bend warning sign and triangular speed sign on the road surface. The triangular speed sign on its own on the road surface did produce a significant result, as did SLOW on the road surface, the chevrons on the bend, and the REDUCE SPEED NOW plate. It is notable that the removal of the bend warning sign on a post produced a significant increase in speeds, whereas placing that sign 200m before the bend rather than just 150m before it produced a significant reduction in speeds.

At the curve mid-point and the end of the curve, the signs which produced a significant result were the same. These were: SLOW on the road surface; the triangular speed sign on the road surface and the REDUCE SPEED NOW plate, i.e. the same as for the curve entry point with the exception of the chevrons and the bend warning sign 200m before the bend.

Of the signs only the triangular speed sign on the road surface produced a significantly different range of lateral position values from the control.

The effectiveness of signs on the road surface was suggested by Shinar *et al.* (1977), being consistent with their findings that, on the approach to curves, drivers shift their attention from the focus of expansion of the field of view to alternating between the road ahead and lane markings at the edge of the road.

As far as those treatments which were applied to both left and right-hand bends, there was no significant effect of bend direction for any of these treatments (i.e. B1.10 vs. B1.21, p=0.8684; B1.13 vs. B1.22, p=0.4074; B1.18 vs. B1.23, p=0.1930; B1.01 vs. B1.19, p=0.3812).

It is the curve entry speed and lateral position which are most important in the safe negotiation of bends. Of the non-sign treatments the transverse lines to the curve mid-point produced the lowest score when mean speed and V85 were considered, while the transverse lines to the curve entry point were second. The former was therefore selected for further investigation in phase two. Joint third were the hatched shoulders and Wundt illusion, with the central hatching and central transverse lines being joint fifth. The aim of phase two was to investigate whether speeds could be reduced further by combining treatments. Thus two of most effective non-sign treatments were combined with each other and with the most effective sign treatments.

7.4.BEND TREATMENTS — PHASE TWO

These treatments were all applied to 300m radius left-hand bends, except for treatment 18 which was on a right-hand bend. Table 3.9 shows the range of the change obtained for various aspects of the distribution of speeds relative to control for the phase two bend treatments (B2.01 to B2.17).

The size of maximum reduction in mean speed was similar to those obtained in phase one. The V85 result was lower than that for the phase one non-sign treatments, but higher than the phase one sign treatments. The reduction in speed variance, however, was much larger than that obtained in phase one. In percentage terms the maximum reductions were still lower than those obtained for the phase two village treatments.

Table 3.9: Range of change in speed, for phase two bend treatments.

	Lowest speed in mph (treatment)	Highest speed in mph (treatment)	Control speed in mph	Range of change (mph)
Mean speed	41.51 (B2.14)	44.78 (B2.02)	45.08	–3.57 (–7.9%) to –0.30
85th %ile speed	51.79 (B2.14)	57.89 (B2.05)	57.31	–5.52 (–9.6%) to +0.58
Speed variance	53.46 (B2.08)	101.86 (B2.07)	93.36	–39.90 (–42.7%) to +8.50

At the curve entry point, when the ranks of mean speed and V85 are considered (BENDS3 score, Table 8.13), the most effective treatments were: the transverse lines to the curve mid-point + the triangular speed sign on the road surface (B2.14), with a score of 4; the transverse lines + SLOW on the road surface (B2.15) with a score of 7; the transverse lines + the centre line with a 2m mark and 2m gap (B2.11), with a score of 10; and SLOW on the road surface (B2.8), also with a score of 10.

Tables 9.07 and 9.08 show the results of the Wilcoxcon matched-pairs signed ranks test for the phase two bend treatments. In phase two, of the treatments tested on 300m radius bends, all the *combinations* of treatments produced speeds significantly different from the control at the curve entry point. The only *individual* treatment to produce a significant result at the 0.05 level was SLOW on the road surface (B2.08). The transverse lines on their own (B2.09) did not produce a significant result at this level (p=0.0582). As already indicated, none of the individual treatments involving shoulders produced a significant result at the curve entry point, nor did the triangular speed sign (on the road or post), nor the REDUCE SPEED NOW plate. In phase one, most of these individual treatments *did* produce a significant effect, but in phase two they were only effective in combination with one another. Possible explanations are that familiarity with the treatments reduces their effectiveness or that exposure to combinations reduces the effectiveness of individual treatments.

Nine of the treatments produced range of lateral position values which were significantly different from the control. It is interesting that many of the individual treatments which produced the significant results at the curve mid-point and at the end of the curve.

It is important to note that there was no significant difference between the speeds produced by the transverse lines and shoulders combination (B2.10) and either of the two individual treatments that make it up (B2.03 p=0.3491 and B2.09 p=0.2485). Nor was there a significant difference between the speeds produced by the transverse lines on their own (B2.09) and treatments B2.12 and B2.13 (transverse lines with signs on posts, p=0.3604 and p=0.4724), or treatments B2.14 and B2.15 (the transverse lines with signs on the road, p=0.0582 and 0.0642 respectively).

There was, however, a significant difference between the speeds produced by the transverse lines on their own (B2.09) and the transverse lines in combination with the centre line with a 2m mark and 2m gap (B2.11, p=0.0198) or with all the signs (B2.16, p=0.0279). The latter is despite the fact that treatments B2.14 and B2.15 actually produced better scores than treatment 2.16 when mean speed and V85 were considered. Since treatment B2.14 produces the lowest mean speed, V85, V50, V75, speed variance and range of lateral position out of treatments B2.14, B2.15 and B2.16, one must conclude that bearing in mind the aim to reduce the speeds of the fastest drivers and the cost of the additional signs this would be the most desirable treatment of the three.

In summary, of the phase two treatments, the most promising treatments for bends are transverse lines to the curve mid-point either combined with a centre line with a 2m mark and 2m gap on the approach (B2.11) or with a triangular advisory speed sign painted on the road surface (B2.14). There was no significant difference between the speeds produced by these two treatments (p=0.4724).

The findings of previous studies on the effects of advisory speed signs are contradictory and the type of sign used in this study was very different to those used in previous studies (see Zwahlen, 1987). The effectiveness of the centre line with a 2m mark and 2m gap in combination with the transverse lines is surprising, given that it was not effective on its own. Further evaluation of this treatment may be justified to confirm this finding.

As far as the *effect of bend direction and radius* are concerned, treatments B2.16 and B2.18 to B2.22 were all treated in the same way, but on both right and left-hand bends of three different radii. There was a significant difference between the 300m radius left-hand bend and both the 80m radius left-hand bend (B2.16 vs. B2.19, p=0.0002), and the 500m radius left-hand bend (B2.16 vs. B2.21, p=0.0002). Thus radius is an important factor affecting speed on left-hand bends. There was, however, no significant difference between the speeds produced by the 300m radius right-hand bend and either the 80m radius right-hand bend (B2.18 vs. B2.20, p=0.4997), or the 500m radius right-hand bend (B2.18 vs. B2.22, p=0.0778). Thus radius does not appear to be an important factor affecting speed on right-hand bends. This may be because drivers acquire most of their information about right-hand bends on the approach to the curve, whereas on left-hand curves they tend to acquire information while actually negotiating it (Shinar *et al.*, 1977), thus the radius of the right-hand bends may have been more of a surprise to the subjects. This may have been reinforced by the fact that most of the bends were left-hand bends and that the occurrence of a right-hand bend was in itself a surprise to the subjects.

There was no significant difference between the speeds produced by the 300m radius left-hand bend and the 300m right-hand bend (B2.16 vs. B2.18, p=0.2145), but there was a significant difference between the speeds produced by the 80m radius left-hand bend and the 80m right-hand bend (B2.19 vs. B2.20, p=0.0002), and between the speeds produced by the 500m radius left-hand bend and the 500m right-hand bend (B2.21 vs. B2.22, p=0.0002). Thus direction of bend is a factor affecting speeds for bends of 80m or 500m radius, but not for bends of 300m radius. This was reinforced by the results of phase one where those treatments which were applied to both left and right-hand (300m radius) bends, produced no significant effect of bend direction for any of these treatments. Speeds were, in fact, slower on the right-hand bends, which may, again be due to the fact that drivers acquire most of their information about right-hand bends on the approach to the curve. It may also be partially due to the fact that the subjects were expecting bends of 300m radius, since most of the bends were of this radius.

7.5.GENERAL TREATMENTS — PHASE ONE

Table 3.10 shows the range of the change obtained for various aspects of the distribution of speeds relative to control for the phase one general treatments.

Table 3.10: Range of change in speed, for phase one general treatments.

	Lowest speed in mph (treatment)	Highest speed in mph (treatment)	Control speed in mph	Range of change (mph)
Mean speed	51.96 (G1.07)	59.90 (G1.10)	58.79	–6.83 (–11.6%) to +1.11
85th %ile speed	65.20 (G1.06)	74.82 (G1.03)	71.56	–6.36 (–8.9%) to +3.26
Speed variance	92.09 (G1.05)	145.67 (G1.10)	124.96	–32.87 (–26.3%) to +20.71

The percentage maximum reduction in speed variance is much lower than for the bend and village treatments. For the V85 the percentage maximum reduction is also quite low. It is the reduction in mean speeds which is most impressive. This is not necessarily the most desirable outcome for treatments designed for relatively straight sections of roads, since V85 and speed variance are likely to be more important in safety terms.

Five of the ten treatments produced a V85 lower than the control. These all produced a V85 more than 2.5mph lower than the control.

When the ranks of mean speed and V85 are considered (GENERL2 score, Table 8.14), the five most effective treatments were: the 4m central hatching, with a score of 4; the third lane, with a score of 5; the 6m carriageway and the double centre line, both with a score of 6; and the 2m shoulder, with a score of 9. These are the same five treatments which produced a V85 which was less than the control.

When the rank of speed variance is considered in addition to mean speed and V85 (GENERL2 score, Table 8.14), the five most effective treatments were: the third lane and double centre line, both with a score of 8; the 4m central hatching, with a score of 9; the 2m shoulder with a score of

13; and the centre line with a 2m mark and a 2m gap, with a score of 14. Hence the list is similar except for the order and that the centre line with a 2m mark and 2m gap has replaced the 6m carriageway.

Tables 9.09 and 9.10 show the results of the Wilcoxcon matched-pairs signed ranks test for the phase one general treatments. All those treatments which involved some form of narrowing of the lane produced speeds significantly different from the control, as did the double centre line. These treatments all produced a mean speed of between 51.96mph and 56.31mph (a reduction of between 2.48mph and 6.83mph relative to the control) and a V85 of between 65.20mph and 68.98mph (a reduction of between 2.58mph and 6.36mph relative to the control). Trees at the roadside, the type of edge line and the centre line with a 2m mark and 2m gap did not produce a significant result.

It is worth noting that the central hatching (G1.07) and the third lane (G1.09) both produced significantly different speeds from the 2m shoulder (G1.04) (p=0.0158 and 0.0486 respectively), as well as lower mean speeds. There was no significant difference, however, between the speeds for the 2m shoulder and the 6m carriageway (G1.08) at the 0.05 level (p=0.0641); the central hatching and the third lane (p=0.0586); the central hatching and the 6m carriageway (p=0.4939); nor the 6m carriageway and the third lane (p=0.9359). All these treatments involve a 3m lane width.

The effectiveness of lane narrowing is consistent with previous studies (see Pyne, 1995). The fact that in this study the presence of edge lines did not significantly increase speeds is inconsistent with previous studies, although most of these have been carried out on bends where the direction of the road ahead is less clear and drivers are more dependent on delineation (see Pyne 1995).

Given the lack of a significant difference between many of these treatments, the most appropriate treatment for a given road will depend on its width and the particular nature of the accident problem, e.g. is overtaking, or turning or parked vehicles a problem.

As one would expect all the treatments which involved lane narrowing also produced significantly different lateral position values, as did the two treatments involving different centre lines.

It was decided that, since combining these treatments is not appropriate, in phase two, variations in type and degree of narrowing, and type of delineation would be investigated.

7.6.GENERAL TREATMENTS — PHASE TWO

Table 3.11 shows the range of the change obtained for various aspects of the distribution of speeds relative to control for the phase two general treatments.

Table 3.11: Range of change in speed, for phase two general treatments.

	Lowest speed in mph (treatment)	Highest speed in mph (treatment)	Control speed in mph	Range of change (mph)
Mean speed	50.94 (G2.07)	57.74 (G2.05)	58.16	–7.22 (–12.4%) to –0.42
85th %ile speed	60.38 (G2.07)	68.91 (G2.05)	66.34	–5.96 (–8.9%) to +2.57
Speed variance	73.50 (G2.09)	129.30 (G2.10)	80.72	–7.22 (–8.9%) to +48.58

The percentage maximum reduction in mean speed and V85 are comparable to the results obtained in phase one, which is not surprising since no treatment combinations were evaluated. The percentage maximum reduction in speed variance, however, is much lower than in phase, which is important for this type of road section.

When the ranks of mean speed and V85 are considered (GENERL4 score, Table 8.15), the five most effective treatments were: the 4m central hatching with broken lines, with a score of 2; the 2m central hatching + 1m shoulder, with a score of 6; the 6m carriageway, with a score of 7; and the 4m and 2m central hatching with continuous lines, both with a score of 9.

When the rank of speed variance is considered in addition to mean speed and V85 (GENERL2 score, Table 8.15), the five most effective treatments were the same but in a different order.

Tables 9.11 and 9.12 show the results of the Wilcoxcon matched-pairs signed ranks test for the phase two general treatments. In phase two, all the treatments produced speeds significantly different from the control, except the 1.35m shoulder delineated by a broken line, the 7.3m carriageway and the double centre line.

The 1.35m shoulder delineated by a broken line (G2.04) produces significantly different speeds from both the 2m and 1.35m shoulders delineated by continuous lines (G2.04 vs. G2.02, p=0.0249 and G2.04 vs. G2.03, p=0.0057), but the two shoulders delineated by continuous lines are not significantly different from each other (G2.02 vs. 2.03, p=0.8107). Since the shoulders delineated by broken lines produce higher mean speeds than the others, this suggests that shoulders delineated by continuous lines are more effective. It also suggests that shoulder width is not important for widths between 1.35m and 2m. Previous studies have shown that speeds increase as shoulder width increases, but some have studied a larger range of shoulder widths (see Pyne, 1995).

The central hatching delineated by broken lines (G2.07) does not produce significantly different speeds from the central hatching delineated by continuous lines (G2.06) (p=0.0778), nor is there a significant difference between the speeds produced by the 4m and 2.7m central hatching at the 0.05 level (G2.06 vs. G2.08, p=0.0582). These results suggest that type of delineation and width of hatched area is not important.

There is no significant difference between speeds produced by the 2m shoulder with continuous lines and the 6m carriageway (G2.09 vs. G2.06, p=0.4724), nor between the latter and the 4m central hatching with continuous lines (p=0.4204), all of which have a 3m lane width. This suggests that at this lane width the location and type of the narrowing is not important.

There is a significant difference between the speeds produced by the 6m carriageway and the 7.3m carriageway (G2.09 vs. G2.10, p=0.0010). This suggests that carriageway width is an important factor.

There is no significant difference between the 2m central hatching combined with the 1m shoulder (G2.11) and either the 2m shoulder delineated by continuous lines (G2.02) (p=2.145), nor the 4m central hatching delineated by continuous lines (G2.06) (p=0.1841). This also suggests that the location and type of narrowing is not important for this lane width.

All the phase two treatments had a significant effect on lateral position, which is not surprising since, except the double continuous centre lines, they all involve lane narrowing.

8. SUMMARY, CONCLUSIONS AND FURTHER RESEARCH

Substantial reductions in speeds were obtained by some of the treatments evaluated, for all three situations studied. There were also reductions in speed variance. The maximum reductions obtained were as follows (mph):

	mean	**V85**	**variance**
Bends	3.7	7.1	
General	7.2	6.3	33
Villages	4.2	9.4	

These reductions are significant both in statistical and practical road safety terms, so that if they were reproduced in the real world substantial reductions in accident numbers and severity would be obtained.

For the village situation the results suggest that the combination of the chicane without hatching, yellow or white transverse lines throughout the village and countdown speed limits would be the most effective combination of the treatments evaluated for villages. Further simulator and real-world trials to confirm this and evaluate a combination with central hatching or central island, instead of the chicane, would be of value. Since the simulator is now capable of simulating kerbs, evaluation of treatments using these, including a kerbed chicane and central isalnd, would be useful. The effectiveness of the transverse lines despite the lack of a vertical dimension is important.

For the bend treatments the most effective treatments were: transverse lines with reducing spacing (including a central area filled with transverse lines); a central hatched area; a Wundt illusion; and hatched areas at the edges of the road. Further speed reductions may be produced by combining one of the above treatments with the most effective sign treatments — SLOW or a triangular, warning sign style, advisory speed sign painted on the road surface. It is also notable that the removal of the bend warning sign on a post produced a significant increase in speeds, whereas placing that sign 200m before the bend rather than just 150m before it produced a significant reduction in speeds. As far as the radius and direction of the bends is concerned, radius was found to affect speed on left-hand bends, but not on right-hand bends, and the direction of the bend was important for bends of 80m and 500m radius, but not for bends of 300m radius.

For the general treatments all those which involved lane narrowing produced speeds significantly different from the control. Given the lack of a significant difference between many of these treatments, the most appropriate treatment for a given road will depend on its width and the particular nature of the accident problem. In addition, it was found that shoulders delineated by continuous lines were more effective, than those delineated by broken lines. Shoulder width was not important, but carriageway width was. For central hatching, type of delineation and width of hatched area was not important. The location (central/edge) and type (removing carriageway or lane space) of the narrowing was not important.

An notable finding was that once combinations were introduced individual treatments ceased to produce speeds significantly different from those for the control. This means that possible effects on the effectiveness of existing, simpler schemes would have to be taken into account when installing a new one nearby.

The next stage in the work will be to test transferability of the results to real roads, and the persistence of the speed reducing effects of treatments, through trials of the most promising treatments for all three situations — bends, relatively straight sections and villages. It is also planned to pursue the work at a European level, in order to test the applicability of the treatments to southern European roads, where the problems are even more acute. Finally, evaluation of further combinations of and variations on some of the treatments, including those mentioned above, using a driving simulator would be useful.

9.OVERTAKING STUDY

It was originally intended to quantify the magnitude of the deterrence effect of the given treatment by examining where on the section overtaking manoeuvres took place; the curve radius (and sight distance) increased progressively over the length of the stretch of road in question, since the radius of the curves increased progressively. However, it was found that simply examining the number of subjects making an overtaking manoeuvre was sufficient.

A z-test at the 95% confidence level showed that treatments G1.06 (double continuous centre line), G1.07 (central hatched area) and G1.08 (narrow carriageway) all significantly reduced the number of overtaking manoeuvres recorded compared to the control. Treatment G1.04 (wider shoulder and narrower lane) also gave a significant reduction, but only if those overtaking manoeuvres started after the HGV had started to signal were included.

A preliminary study examined whether overtaking manoeuvres could be recognised (and hence predicted) before the vehicle crossed the centre line. To do this, neural networks were trained to distinguish between data taken from two “windows” of lateral position data. These were from either shortly before an overtaking manoeuvre or well before. Some success was achieved in training the networks, but it was concluded that a comprehensive data set containing other parameters such as speed and headway would be likely to yield much better performance.

10.VALIDATION STUDY

10.1.METHODOLOGY

The use of a driving simulator to test different treatments in a controlled way improves the internal validity of the experiments, but being certain of the extent to which the results are transferable to the real world (external validity) becomes a problem. In order to determine the extent to which the speeds obtained on the simulator would be likely to be the same as those obtained in similar circumstances on a real road, a validation study was carried out.

The aims of the validation study were to determine whether the subjects choice of speed is the same in the simulator as it would be on a real road; whether the subjects choice of speed on a real road is the same as that for the generality of drivers on a real road; and also whether the subjects choice of speed is the same in the simulator as that for the generality of drivers on a real road.

In order to make the above comparisons it was necessary to simulate a section of a real road. Desirable characteristics for the section of road were:

1.it should be flat, since the simulator cannot simulate vertical curvature;
2.it should have varied horizontal curvature in order that speeds on straights and bends of a variety of radii could be studied;
3.it should be an open road with little roadside development in order to reduce the number and complexity of items that needed to be simulated;
4.it should have a speed related accident problem;
5.it should be within an hours drive of Leeds.

Humberside was considered to be a logical area to find a road fitting this description. Humberside County Council suggested some alternative sections of roads and an 7km section of the A614 between Howden and Holme-upon-Spalding Moor was selected as best fitting the above criteria.
Between 1stIn respect to point 4, between 1st January 1988 and 31st December 1992, on the section of road which was simulated (between Caville Bends GR: 47680/43010 and Bursea Lane GR: 47980/43515), there were fifty one accidents. Of these forty-one occurred on a link; four at a T-junction; two at a crossroads; and four in driveways. Of the accidents at T-junctions, three involved a right turning vehicle; and one was a single vehicle accident. Of the accidents at a crossroads, one involved a pedestrian; and the other a right turning vehicle. Of the accidents at a drive way, one involved a right turning vehicle; one a vehicle doing a U turn; and two a vehicle waiting to turn right. Of the accidents which occurred on a link, twenty-three were single vehicle accidents, all but two of these being on a bend. Of those accidents which occurred on a link and involved two or more vehicles: four involved head on collisions; five involved a nose to tail collisions; a further six involved overtaking; one involved both a head on collision and a nose to tail collision; one was a side swipe; and one involved a vehicle swerving to avoid an HGV (accident statistics provided by Humberside County Council). The single vehicle accidents on bends and the head on collisions are all likely to have excessive speed as a contributory factor. Excessive speed on the part of one of the involved vehicles is also likely for the accidents at junctions. Speed variance may have been a problem in the nose-to-tail and overtaking accidents.

The section of road was simulated from a 1:10,000 map, road width measurements and a video. To facilitate simulation, the road was broken down into shorter, simplified sections. These shorter sections had to be bends of constant radius and width, or straights, which could vary in width along their length. Superelevation was simulated via an adjustment to the steering model; it could not be represented visually or kinaesthetically.

Speeds were measured at three points, these being between two very sharp bends (about 80m radius), between two less sharp bends (about 630m radius) and in the middle of a long straight. Speeds were measured at these points for the subjects when driving on the simulated A614, for the subjects when driving on the real A614, and for real road users on the real A614.

The subjects which took part in the validation study were from the group which experienced the general treatments only. These subjects drove along the real A614 in a hired medium sized saloon car. They were given time to get used to the car before driving along the instrumented stretch of road.

Subjects speeds were measured using three Golden River “Archer” tube classifiers, one at each point. An observer was located at each point and recorded the speeds of the passing hire car from the equipment. Each subject drove along the stretch of road three times, to increase the chances of obtaining a free flow speed for each driver. This took one week and was carried out in July. Speeds of the real road users were measured on a fine Friday in November, at the same three points, but using a radar gun.

The following hypotheses were tested:

1.that the speeds of the subjects when driving on the real A614 are the same as the speeds of the subjects when driving on the simulated A614;

2.that the speeds of the subjects on the real A614 are the same as the speeds of the genuine users of the A614;

3.that the speeds of the subjects on the simulated A614 are the same as the speeds of the genuine users of the A614;

Due to the small sizes of the samples non-parametric tests were used. Wilcoxon's matched-pairs signed-ranks test was used to test the first hypothesis, since the samples are related. The Mann-Whitney *U* test was used to test the other two hypotheses, since the samples are unrelated and of unequal sizes.

The sample sizes at the three sites are shown in Table 4. Some of the data for the subjects on the driving simulator was lost, leaving data for only 14 subjects. This combined with the limited number of subjects for which free flow speeds were obtained on the A614 (between 5, 9 and 11 depending on the site), resulted in the number of subjects for which data was available on both the simulator and the A614 being only 5 for two of the points and even lower for the third. The number of observations for the site between the two gentle bends on the real A614, was small because the tubes broke.

Table 4.1: Sample sizes at the three validation study sites.

Sample	Between sharp bends	Straight	Between gentle bends
Subjects on simulator, hypothesis 1	5	5	-
Subjects on simulator, hypothesis 3	14	14	14
Subjects on real road, hypothesis 1	5	5	-
Subjects on real road, hypothesis 2	9	11	5
Genuine drivers on real road, hypotheses, 2 & 3	30	30	30

10.2RESULTS

The first null-hypothesis was rejected for the point on the straight (p=0.0431), but not for the point between sharp bends (p=0.8927). It was not tested at the other point due to lack of data. Thus there was no significant difference between the speeds of the subjects when driving on the real A614 and the speeds of the subjects when driving on the simulated A614 for the point between the sharp bends, but for the point on the straight, speeds were higher for the subjects on the simulated A614 than for the subjects on the real A614. The second null-hypothesis was not rejected at any of the three points (p=1.0000, p=0.1291, p=0.4787 for sharp bend, straight, and gentle bend respectively). Thus the speeds of the subjects on the real A614 were the same as the speeds of the genuine users of the A614, at all three points. The third null-hypothesis was rejected for the point on the straight (p=0.0044) and for the point between the gentle bends (p=0.0006), but not for the point between the sharp bends (p=0.1428). Thus the speeds of the subjects on the simulated A614 were significantly different from (in fact faster than) the speeds of the genuine users of the A614 at the point on the straight and the point between gentle bends, but they were not significantly different between the sharp bends.

10.3.CONCLUSIONS

Overall, the validation study indicated that speeds adopted on the driving simulator are significantly faster than those adopted on a real road at points where speeds are not constrained by the horizontal alignment of the road. However, it should be noted that the simulator is undergoing continual improvements, and the visual and sound systems have both been upgraded since the experiments were conducted. It is expected that speed perception will be improved by these upgrades.

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APPENDIX 1 — DETAILS OF TREATMENTS

Village Treatments — Phase One

V1.01 Village sign and speed limit sign 150m from start of buildings, urban centre line (1m mark, 5m gap) and continuous edge lines between speed limit signs, otherwise rural centre lines (2m mark, 7m gap), edge lines with 1m mark and 3.5m gap (control and practice).

All the following have edge and centre lines and signs as for control unless otherwise stated. Treatments involving narrowing also have the appropriate road narrows sign 150m before start of narrowing. Any central areas, shoulders and the chicane are delineated by continuous lines. All treatments start on the approach to the village and continue through it unless otherwise stated.

V1.02 Trees at roadside, on both sides, on approach to village.
V1.03 Broken centre lines with lines getting progressively closer together up to start of village, then gap remains constant size through village.
V1.04 Centre line with 2m mark and 2m gap.
V1.05 Wundt illusion on approach to village (chevrons across entire width of road, chevrons get less sharp as approach start of village)
V1.06 Transverse line across lane with reducing spacing on approach to village.
V1.07 Hazard marker posts with 10m spacing on both sides of approach to village.
V1.08 Chicane, delineated by hatched areas.
V1.09 Road narrowing by nearside parking bay, and delineated by line with 1m mark and 1m gap.
V1.10 Road narrowing by central hatched area, with road narrows sign.
V1.11 Road narrowing by central hatched area, without road narrows sign.
V1.12 Road narrowing by central area with transverse lines with reducing spacing.
V1.13 Road narrowing by shoulder with hatching.
V1.14 Road narrowing by shoulder with transverse lines.
V1.15 Street lights.
V1.16 SLOW on road surface alongside village sign.
V1.17 Speed limit on road surface alongside village sign (circular sign).
V1.18 Count down speed limit signs.

Bend Treatments — Phase One

Left-hand bends

B1.01 Bend warning sign 150m from start of curve, double continuous centre lines (150mm wide) on curve; double line, one continuous and one permissive broken (1m mark, 5m gap, 150mm wide) for 90m before start of curve; otherwise rural centre lines (2m mark, 7m gap); broken edge lines with 1m mark and 3.5m gap; arrow alongside warning sign. (control and practice).

B1.02 Centre lines and sign as control but no edge lines on approach or bend.
B1.03 Centre lines and sign as control but broken edge lines (1m mark, 3.5m gap) on approach and bend.

All the following have road markings and signs as control unless otherwise stated.

B1.04 Hazard markers on outside of bend (10m spacing).
B1.05 Hazard markers on both sides of bend (10m spacing).
B1.06 Trees at roadside, on both sides.
B1.07 Centre line with 2m long marks but gaps reducing in length by 0.25m steps, on curve approach, double continuous centre lines on bend.

B1.08 Warning centre line (6m mark, 3m gap) on 150m approach to curve (plus continuous centre line for 90m before curve entry point, making the centre line double over this stretch).
B1.09 Centre line with small gap (2m mark, 2m gap) on 150m approach to curve (plus continuous centre line for 90m before curve entry point, making the centre line double over this stretch).
B1.10 Transverse lines with reducing spacing, across carriageway, between warning sign and curve mid-point.
B1.11 Transverse lines with reducing spacing, across carriageway, between warning sign and curve entry point.
B1.12 Transverse lines with reducing spacing, in centre of carriageway, between continuous white lines (2.7m apart), to centre of curve. curve (3.65m lane width).
B1.13 Narrowing using hatched central area 2.7m wide (3.65m lane width).
B1.14 Wundt illusion (herringbone type road marking across entire width of road, chevrons get less sharp as approach bend).

Following four treatments have continuous edge line at edge of carriageway between warning signs, and line with 1m mark and 1m gap along outside edge of lane all narrowing over 150m of curve approach, unless otherwise stated:-

B1.15 Narrowing with 1.35m wide hatched shoulders (3.65m lane width).
B1.16 Narrowing with transverse lines with reducing spacing, in 1.35m wide shoulders (3.65m lane width).
B1.17 Narrowing with 1.35m wide unmarked shoulders (3.65m lane width).
B1.18 Narrowing with 2.7m wide unmarked shoulder at nearside edge of road (3.65m lane width).

Right-hand bends

B1.19 As B1.01
B1.20 Centre and edge lines as control but no warning sign.
B1.21 As B1.10
B1.22 As B1.13
B1.23 As B1.18
B1.24 SLOW on road surface adjacent to warning sign.
B1.25 Bend warning sign on road surface adjacent to bend warning sign on post.
B1.26 Advisory speed limit sign and bend warning sign (triangular signs) on road surface adjacent to bend warning sign on post.
B1.27 Advisory speed limit sign on road surface adjacent to bend warning sign on post.
B1.28 Bend warning sign 200m from curve entry point.
B1.29 Chevron signs on bend.
B1.30 REDUCE SPEED NOW plate under curve warning sign.

General Treatments — Phase One

G1.01 Rural centre line 2m mark, 7m gap, 100mm wide and edge lines with 1m mark and 3.5m gap, 100mm wide, 225mm from edge of carriageway (control and practice).

All the following also have a rural centre line and edge lines as above on both the straight and curved part of section, unless otherwise stated. The following treatments (or lack of them) are applied to the curved part of the section only unless otherwise stated. Treatments involving narrowing also have the appropriate road narrows sign 150m before start of narrowing.

G1.02 Trees at roadside, on both sides.
G1.03 No edge line, centre line 2m mark and 7m gap.
G1.04 3m lane and 2m shoulder, divided by continuous edge lines (narrowing over last 180m of straight)
G1.05 Centre line with 2m mark, 2m gap and edge line with 1m mark and 3.5m gap.
G1.06 Double continuous centre line (150mm wide and 175mm apart) and edge line with 1m mark and 3.5m gap.

G1.07 Road narrowing by 4m central hatched area (3m lane width), hatched area surrounded by continuous lines, edge line with 1m mark and 3.5m gap. Narrowing over last 200m of straight.

G1.08 Narrow carriageway to 6m, with 3m wide lanes. Narrowing over last 200m of straight. Road markings as for control.

G1.09 Narrow lanes by addition of third lane. Left and right-hand lanes 3.4m wide. Centre lane 3.2m wide. Edge lines continuous. Double line between centre lane and right-hand lane has broken line to left with 1m mark and 5m gap, and continuous line to right. Both 150mm wide and 175mm apart. Lane line between left-hand lane and centre lane has 2m mark and 7m gap and is 100mm wide.

G1.10 Continuous edge lines, centre line 2m mark and 7m gap.

Villages — Phase Two

Treatments in italics were used in phase one.

V2.01Village sign and speed limit sign 150m from start of buildings, urban centre line (1m mark, 5m gap) and continuous edge lines between speed limit signs, otherwise rural centre lines (2m mark, 7m gap), edge lines with 1m mark and 3.5m gap (control and practice).

All the following have edge and centre lines and signs as for control unless otherwise stated. Treatments involving narrowing also have the appropriate road narrows sign 150m before start of narrowing. Chicanes and narrowing are delineated by continuous white lines.

V2.02Hazard marker posts 10m spacing.
V2.03Hazard marker posts reducing spacing. Hazard marker posts on both sides of carriageway between speed limit signs and start of buildings, as above, but getting closer together as approach start of buildings. Use same spacing as for transverse lines if possible. Road markings as for V2.01.
V2.04Countdown speed limit signs.
V2.05Speed limit on road surface (circular sign).
V2.06Countdown speed limit signs on posts and speed limit on road surface (i.e. as V2.04 + V2.05)
V2.07Chicane with hatching.
V2.08Chicane without hatching (i.e. as V2.07 but no hatching).
V2.09Yellow transverse lines with reducing spacing, between speed limit signs and start of buildings.
V2.10White transverse lines with reducing spacing, between speed limit signs and start of buildings. (i.e. as V2.09 but white transverse lines).
V2.11Yellow transverse lines with reducing spacing between speed limit signs and start of buildings (as V2.09), then with constant spacing through village which stop at end of buildings.
V2.12White Wundt illusion between speed limit signs and start of buildings.
V2.13Yellow Wundt illusion between speed limit signs and start of buildings (i.e. as V2.12 but yellow Wundt illusion lines).
V2.14Yellow Wundt illusion between speed limit signs and start of buildings, then straight lines with constant spacing (same spacing as for transverse lines) through village which stop at end of buildings.
V2.15Chicane without hatching, plus yellow transverse lines. Transverse lines are between white lines delineating chicane only. Transverse lines reduce in spacing between speed limit signs and start of buildings, then have constant spacing through village and stop at end of buildings (i.e. V2.08 + V2.11), but transverse lines do not go all the way across the lane.
V2.16As V2.15 but with hazard marker posts with 10 m spacing (i.e. V2.15 + V2.02).
V2.17As V2.15 but with countdown speed limit signs (i.e. V2.15 + V2.04).
V2.18As V2.15 but with speed limit on the road surface (i.e. V2.15 + V2.05).
V2.19As V2.15 but with hazard marker posts, countdown speed limit signs and speed limit on the road surface (i.e. V2.15 + V2.04 + V2.02 + V2.05).
V2.20As V2.19 but without chicane (i.e. V2.19 - V2.08).
V2.21Wundt illusion in yellow as V2.14 Also countdown speed limit signs, hazard marker posts with 10 m spacing and speed limit on the road surface (i.e. V2.14 + V2.02 + V2.04 + V2.05).

Bends — Phase Two

Treatments in italics were used in phase one. All on left-hand bends unless otherwise stated.

B2.01Bend warning sign 150m from start of curve, double continuous centre lines (150mm wide) on curve; double line, one continuous and one permissive broken (1m mark, 5m gap, 150mm wide) for 90m before start of curve; otherwise rural centre lines (2m mark, 7m gap); broken edge lines with 1m mark and 3.5m gap; arrow alongside warning sign. (control and practice).

B2.021.35m shoulders delineated by line with 1m mark and 1m gap.
B2.031.35 m shoulders delineated by continuous white lines. No edge line.
B2.041.35m hatched shoulders delineated by line with 1m mark and 1m gap.
B2.05Triangular advisory speed sign on post.
B2.06REDUCE SPEED NOW plate on post.
B2.07Triangular advisory speed sign on road surface.
B2.08SLOW on road surface.
B2.09Yellow transverse lines with reducing spacing, to curve mid-point.
B2.101.35 m shoulders (delineated by continuous white lines, as in B2.03), with yellow transverse lines with reducing spacing between the shoulders (not in the shoulders i.e. not all the way across lane as in B2.09), and up to the curve mid point. Rural centre line on approach.
B2.11As B2.10 but with centre line with 2m mark and 2m gap on approach.
B2.12As B2.10 but with bend warning sign and triangular advisory speed sign, both on post (first named at top).
B2.13As B2.10 but with bend warning sign, triangular advisory speed sign, and REDUCE SPEED NOW plate, all on post (first named at top).
B2.14As B2.10 but with triangular advisory speed sign on road surface.
B2.15As B2.10 but with triangular advisory speed sign and SLOW on road surface (SLOW nearest village).
B2.16As B2.13 + B2.15
B2.171m hatched shoulders, delineated by lines with 1m mark and 1m gap; 2m central hatched area, delineated by continuous white lines; continuous edge lines.
B2.18As B2.16 but on right-hand bend.
B2.19As B2.16 but on 80m radius curve.
B2.20As B2.16 but on 80m radius right-hand curve.
B2.21As B2.16 but on 500m radius curve.
B2.22As B2.16 but on 500m radius right-hand curve.

General Treatments — Phase Two

Treatments in italics were in phase one. All on right-hand bends unless otherwise stated.

G2.01Rural centre line 2m mark, 7m gap, 100mm wide and edge lines with 1m mark and 3.5m gap, 100mm wide, 225mm from edge of carriageway (control and practice).

All the following also have a rural centre line and edge lines as above on both the straight and curved part of section, unless otherwise stated. The following treatments (or lack of them) are applied to the curved part of the section only unless otherwise stated. Treatments involving narrowing also have the appropriate road narrows sign 150m before start of narrowing.

G2.023m lane and 2m shoulder, delineated by continuous edge lines (narrowing over last 180m of straight)
G2.033.65m lane and 1.35m shoulder, delineated by continuous edge lines (narrowing over last 110m of traight)
G2.043.65m lane and 1.35m shoulder, delineated by edge lines with 1m mark and 1m gap (narrowing over last 110m of straight)
G2.05Double continuous centre line (150mm wide and 175mm apart) and edge line with 1m mark and 3.5m gap.
G2.06Road narrowing by 4m central hatched area (3m lane width). Hatched area delineated by continuous line; edge line with 1m mark and 3.5m gap. Narrowing over last 200m of straight.
G2.07As G2.06 but hatched area delineated by line with 6m mark and 3m gap
G2.08Road narrowing by 2.7m wide central hatched area (3.65m lane width). Hatched area delineated by continuous lines; edge line with 1m mark and 3.5m gap. Narrowing over last 135m of straight.
G2.09Narrow carriageway to 6m, with 3m wide lanes. Narrowing over last 200m of straight. Road markings as for control.
G2.10Narrow carriageway to 7.3m, with 3.65m wide lanes. Narrowing over last 135m of straight. Road markings as for control.

G2.112m wide central hatched area and 1m wide shoulders (both delineated by continuous lines).

Village Treatments — Considered but not used

V3.01Fence at roadside, on both sides.
V3.02Centre line with 4m mark and 2m gap.
V3.03Hazard marker posts with 10m spacing on nearside of approach to village.
V3.04Hazard marker posts with reducing spacing up to start of village, nearside of road only.
V3.05Road narrowing by central hatching on approach only (1:50, 100m inclines + 10m straight)
V3.06Road narrowing by offside parking bay (1:50, 180m incline)
V3.07Road narrowing by central hatching (1:50, 100m incline + 50m straight, +trees).
V3.08Road narrowing by central hatching (1:50, 100m incline, 100m straight).
V3.09Road narrowing by central hatching (1:50, 100m incline).
V3.10Road narrowing by central hatching (1:100, 200m incline).
V3.11No speed limit sign.
V3.12Speed limit sign alongside village sign with red and white bars beneath.

General Treatments — Considered but not used

G3.01Fence at roadside, on both sides.
G3.02Centre line with 3m mark, 3m gap and edge line with 1m mark and 3.5m gap.
G3.03Centre line with 2m mark, 4m gap and edge line with 1m mark and 3.5m gap.
G3.04Centre line with 4m mark, 2m gap and edge line with 1m mark and 3.5m gap.
G3.05Centre line with 2m mark, 7m gap and edge line with 1m mark and 3.5m gap.
G3.06Centre line with 6m mark, 3m gap and edge line with 1m mark and 3.5m gap.
G3.07Centre line with 2m mark, 2m gap and edge line with 1m mark and 1m gap.
G3.08Centre line with 2m mark, 7m gap and edge line with 1m mark and 1m gap.
G3.09Double continuous centre line (150mm wide and 175mm apart) and no edge line.

Bend Treatments — Considered but not used

All the following have road markings and signs as control unless otherwise stated.

B3.01Hazard markers with reduced spacing from bend warning sign to centre of curve on outside of bend.
B3.02Hazard markers with reduced spacing from bend warning sign to centre of curve on both sides of bend.
B3.03Fence at roadside, on both sides.
B3.04Broken edge lines with 1m long lines, but gaps reducing in length by 0.05m steps on curve approach, continuous edge lines on bend.
B3.05Broken edge lines with 0.6m long lines, but gaps reducing as D18-D66 on curve approach, continuous edge lines on bend.
B3.06Edge lines **and** centre line getting progressively closer together on approach.
B3.07Transverse lines across carriageway with reducing spacing between warning sign and centre of curve (D45-D90)
B3.08Transverse lines in centre of carriageway, between continuous white lines (4m apart), at reducing spacing as approach centre of curve (spacing D1 to D66, 3m lane width).
B3.09Narrowing using hatched central area 4m wide (3m lane width)

Following treatments have continuous edge line at edge of carriageway between warning signs, and line with 1m mark and 1m gap along outside edge of lane all narrowing over 150m of curve approach, unless otherwise stated:-

B3.10Narrowing with 2m wide hatched areas at edges of road (3m lane width).
B3.11Narrowing with 2m wide unmarked areas at edges of road (3m lane width)

Details of Village Treatments

The sections consist of an 800m straight, followed by a 400m straight with buildings alongside. Points V1 and V2 are at either end of the 400m straight and points X1 and X2 are 150m from V1 and V2 on the approaches to the village. All sections have village name sign and speed limit sign at X1 and X2. Treatments involving road narrowing also have an appropriate road narrows warning sign 150m before narrowing starts.

V1.01Urban centre line (1m mark, 5m gap, 100mm wide) and continuous edge lines, 100m wide, between points X1 and X2; otherwise use rural centre line (2m mark, 7m gap, 100mm wide); and edge line with 1m mark and 3.5m gap and 100mm wide (control and practice).

V1.02As control but with trees between points V1 and X1, and V2 and X2 on both sides of road.

V3.01As control but with fence between points V1 and X1, and V2 and X2 on both sides of road .

V1.03Centre lines getting progressively closer together between points X1 and V1 and between X2 and V2. The centre lines between points V1 and V2 have constant gap size i.e.:-

Centre lines have 2m long marks, but gaps reduce in 0.25m steps starting at points X1 and X2 and working towards points V1 and V2. When a 1m gap is reached, the gap size is not reduced further, the remaining distance being filled in with 2m lines 1m apart.

V3.02Centre line between X1 and X2 has 4m mark and 2m gap.

V1.04Centre line between X1 and X2 has 2m mark and 2m gap.

V1.05Wundt illusion: between X1 and V1, chevrons pointing away from village and across the entire width of the carriageway, get less sharp as the village is approached, the chevron at V1 being in fact a straight line. The distance between them at the edge of the carriageway remains a constant 15m. The distances of the points of the chevrons from V1 are as follows: 17m, 34m, 51m, 68m, 85m, 102m, 119m, 136m, 153m. The mirror image of the pattern shown is used between points X2 and V2. Otherwise road markings as for V1.01

V1.060.6m wide transverse lines across the left-hand lane starting at X1 and getting closer together as V1 is approached. The line spacing as for D1 to D45 on the attached sheet, where D1 is at V1 and D45 close to X1. The mirror image is used on the opposite side of the road between X2 and V2. Otherwise road markings as for V1.01

V1.07Hazard marker posts 10m apart from X1 to V1 and X2 to V2 on both sides of the road. Road markings as for V1.01.

V3.03As V1.07 but on nearside only

V3.04 Hazard marker posts on nearside of carriageway only from X1 to V1 and X2 to V2 getting closer together as approach V1 and V2. Road markings as for V1.01.

V2.03 As V3.04 but on both sides of carriageway.

V3.05 Central hatched area widens to 4m over the 50m to either side of X1 (100m in total) (1:50), then continues at 4m wide for 10m, then narrows to nothing over next 100m towards centre of village. Second central hatched area widens to 4m over the 50m to either side of X2 (1:50), then continues at 4m wide for 10m, then narrows to nothing over next 100m towards centre of village. Edge lines are continuous. Lines around central hatched areas have 4m mark and 2m gap.

V1.08 Chicane. Hatched area at edge of road, to both sides of road, widens from X1 to 2m wide over 90m (1:50), continues at 2m wide until V1. Then it narrows to 225mm at 100m into village, widens to 2m again over next 100m, to centre of village, narrows again over next 100m and widens to 2m again over last 100m of village.

Central hatched area widens to 4m wide from V1 to point 100m into village, then narrows to nothing over next 100m to centre of village. Repeat central hatched area over next 200m, from centre of village to V2. Lane widths narrow from 5m at X1 and X2 to 3m at V1 and V2.

Centre line has 4m mark and 2m gap including lines around central hatched areas. Edge lines are continuous.

V1.09 Road narrowing to near side of road, 1:50. From left to right — hatched area to one edge of road widens to 4m wide over the 180m before V1. This is followed by an unhatched lay-by 4m wide through village and then an inclined hatched area which narrows from 4m wide at V2 to nothing over the 180m after V2.

Centre line has 1m mark and 5m gap, edge lines are continuous except along the edge of the 4m wide lay-by formed between the two inclined hatched areas, where they have 1m mark and 1m gap.

V3.06 As V1.09 but road narrows on opposite side.

V1.10Central hatched area widens to 4m from X1 over 100m (1:50), then continues at 4m wide until centre of village, then mirror image from centre of village to X2. Edge lines continuous. Lines around central hatched area have 4m mark and 2m gap.

V1.11As 1.10 but with no "road narrows" sign.

V3.07 As 1.10 but with trees in central area.

V1.12As 1.10 but with transverse lines in central area, not hatching.

V3.08Central hatched area widens to 4m over the 50m to either side of X1 (100m in total) (1:50), then continues at 4m wide until centre of village, then mirror image from centre of village to X2. Edge lines continuous. Lines around central hatched area have 4m mark and 2m gap.

V3.09 Central hatched area widens to 4m over the 100m before V1 (1:50), then continues at 4m wide until centre of village, then mirror image from centre of village to X2. Edge lines continuous. Lines around central hatched area have 4m mark and 2m gap.

V3.10Central hatched area widens to 4m over the 200m before V1 (1:100), then continues at 4m wide until centre of village, then mirror image from centre of village to X2. Edge lines continuous. Lines around central hatched area have 4m mark and 2m gap.

V1.13Narrowing on both sides of road. From left to right — hatched area on both sides widens from X1 to 2m wide over 90m (1:50), continues at 2m wide until 90m before X2 then narrows to 225mm again. Edge lines are continuous. Centre line has 1m mark and 5m gap.

V1.14 Narrowing on both sides of road. From left to right — area with transverse lines on both sides widens from X1 to 2m wide over 90m (1:50), continues at 2m wide until 90m before X2 then narrows to 225mm again. Edge lines are continuous. Centre line has 1m mark and 5m gap.

V1.15Street lights between village signs.

V1.16SLOW on road surface alongside village sign.

V1.17Speed limit on road surface alongside village sign (circular sign).

V1.18Count down speed limit signs.

V3.11No speed limit sign.

V3.12Speed limit sign alongside village sign with red and white bars beneath

APPENDIX 2 — QUESTIONNAIRE

[ ]

We would like to know some background information about yourself, the type and quantity of your driving experience, and your opinions about the driving simulator.

The results will be presented in such a way, that it will not be possible to identify individual responses. No names will be used. Please answer the questions as accurately and honestly as possible.

1. Date: (e.g. 1 / 6 for 1st June) [/]

2. Time of appointment: (e.g. 2:30) [:]

3. What is your age? [ ]

4. Are you male or female? (Please tick)
   Male [ ]
   Female [ ]

5. In which year did you get your driving licence? [ ]

6. How many years have you been driving **regularly**? [ ]

7. How many driving tests did you take, including the one you passed? [ ]

8. Have you passed any additional driving courses?
   (Please put a tick against any you have passed)
   Advanced [ ]
   Instructors [ ]
   Motorcycle [ ]
   HGV [ ]
   PSV [ ]
   Other, please specify
   [ ]
   None [ ]

9. Do you have any **current** penalty points on your licence?
   Yes [ ]
   No [ ]

   If yes, what were they for? ______________________________

10. How many accidents in which someone has been injured have you been involved in as a **driver** over the last three years? [ ]

11. How many accidents in which someone has been injured have you been involved in as a **passenger** over the last three years? [ ]

12. Please estimate **your** mileage over the last year, (including journeys to work, in the course of work, shopping, personal business,

transporting children, visiting friends, leisure and holidays)? [ ]

PLEASE TURN OVER

13.Please estimate how often you have driven over the last year?

Daily [ ]
Several times a week [ ]
Several times a month [ ]
Less often than monthly [ ]
Not at all [ ]

14. Please estimate how often you have driven on rural A roads over the last year? (e.g. A64 or A65 outside the built up area).

Daily [ ]
Several times a week [ ]
Several times a month [ ]
Less often than monthly [ ]
Not at all [ ]

15. Do you drive as part of a job? (Please tick, do not include driving to and from work)

Yes, daily [ ]
Yes, several times a week [ ]
Yes, several times a month [ ]
Yes, less often than monthly [ ]
No, not at all [ ]

Now some questions about the **driving simulator.**

16. How easy did you find it was to control your speed?
(Please enter a number from 1 to 5, where **1 is very easy** and **5 is very hard**) [ ]

17. How easy did you find it was to control your position on the road?
(Please enter a number from 1 to 5, where **1 is very easy** and **5 is very hard**) [ ]

18. Did you feel ill when using the simulator? (Please tick) Yes [ ]
No [ ]

19. If you did feel ill, how long after starting to drive the simulator did you begin to feel ill? (Please enter the time in minutes, do not include the break) [ ]

20. Do you have any other comments about the driving simulator?

____

THANK YOU

PLEASE TAKE CARE ON YOUR WAY HOME

APPENDIX 3 — FREQUENCIES OF QUESTIONNAIRE RESPONSES FOR PHASE ONE SUBJECTS

A. VILLAGES GROUP

AGEGROUP

Value	Frequency	Percent	Valid Percent	Cum Percent
20-29	8	44.4	44.4	44.4
30-39	4	22.2	22.2	66.7
40-49	2	11.1	11.1	77.8
50-59	2	11.1	11.1	88.9
60+	2	11.1	11.1	100.0
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

AGEGRP

Value	Frequency	Percent	Valid Percent	Cum Percent
30+	10	55.6	55.6	55.6
<30	8	44.4	44.4	100.0
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

SEX

Value	Frequency	Percent	Valid Percent	Cum Percent
Female	9	50.0	50.0	50.0
Male	9	50.0	50.0	100.0
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

YRSREGGP

How many years have you been driving regularly?

Value	Frequency	Percent	Valid Percent	Cum Percent

1-4	2	11.1	11.1	11.1
5-9	4	22.2	22.2	33.3
10-14	8	44.4	44.4	77.8
15-24	2	11.1	11.1	88.9
25-34	2	11.1	11.1	100.0
	-------	-------	-------	
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

TESTNO
How many driving tests did you take?

Value	Frequency	Percent	Valid Percent	Cum Percent
1	7	38.9	38.9	38.9
2	5	27.8	27.8	66.7
3	6	33.3	33.3	100.0
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

TESTYPE
Have you passed any additional driving courses?

Value	Frequency	Percent	Valid Percent	Cum Percent
None	15	83.3	83.3	83.3
Instructors	1	5.6	5.6	88.9
Tracked	1	5.6	5.6	94.5
Taxi	1	5.6	5.6	100.0
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

POINTS
Do you have any current penalty points on your licence?

Value	Frequency	Percent	Valid Percent	Cum Percent
No	13	72.2	72.2	72.2
Yes	5	27.8	27.8	100.0
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

TOTMGP
What was your total mileage over the last year?

Value	Frequency	Percent	Valid Percent	Cum Percent

<10,000	8	44.4	44.4	44.4
10,000-19,000	7	38.9	38.9	83.3
20,000-29,000	1	5.6	5.6	88.9
40,000-49,000	2	11.1	11.1	100.0
	-------	-------	-------	
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

DRVFREQ
How often have you driven over the last year?

Value	Frequency	Percent	Valid Percent	Cum Percent
Daily	12	66.7	66.7	66.7
Several times a week	5	27.8	27.8	94.4
Several times a month	1	5.6	5.6	100.0
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

RURMILES
How often have you driven on rural roads over the last year?

Value	Frequency	Percent	Valid Percent	Cum Percent
Daily	5	27.8	27.8	27.8
Several times a week	6	33.3	33.3	61.1
Several times a month	5	27.8	27.8	88.9
Less often than monthly	2	11.1	11.1	100.0
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

JOBDRIVE
How often do you drive as part of a job?

Value	Frequency	Percent	Valid Percent	Cum Percent
Never	12	66.7	66.7	66.7
Daily	1	5.6	5.6	72.2
Several times a week	2	11.1	11.1	83.3
Several times a month	1	5.6	5.6	88.9
Less often than monthly	2	11.1	11.1	100.0
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

B. BENDS GROUP

AGEGROUP

Value	Frequency	Percent	Valid Percent	Cum Percent
18-19	2	11.8	11.8	11.8
20-29	6	35.3	35.3	47.1
30-39	3	17.6	17.6	64.7
40-49	2	11.8	11.8	76.5
50-59	3	17.6	17.6	94.1
60+	1	5.9	5.9	100.0
Total	17	100.0	100.0	

Valid cases 17 Missing cases 0

AGEGRP

Value	Frequency	Percent	Valid Percent	Cum Percent
30+	9	52.9	52.9	52.9
<30	8	47.1	47.1	100.0
Total	17	100.0	100.0	

Valid cases 17 Missing cases 0

SEX

Value	Frequency	Percent	Valid Percent	Cum Percent
Female	8	47.1	47.1	47.1
Male	9	52.9	52.9	100.0
Total	17	100.0	100.0	

Valid cases 17 Missing cases 0

YRSREGGP
How many years have you been driving regularly?

Value	Frequency	Percent	Valid Percent	Cum Percent
<1yr	2	11.8	11.8	11.8

1-4	3	17.6	17.6	29.4
5-9	4	23.5	23.5	52.9
10-14	3	17.6	17.6	70.6
25-34	2	11.8	11.8	82.4
35-44	3	17.6	17.6	100.0
	-------	-------	-------	
Total	17	100.0	100.0	

Valid cases 17 Missing cases 0

TESTNO
How many driving tests did you take?

Value	Frequency	Percent	Valid Percent	Cum Percent
1	9	52.9	52.9	52.9
2	5	29.4	29.4	82.4
3	3	17.6	17.6	100.0
Total	17	100.0	100.0	

Valid cases 17 Missing cases 0

TESTYPE
Have you passed any additional driving courses?

Value	Frequency	Percent	Valid Percent	Cum Percent
None	12	70.6	70.6	70.6
Instructors	1	5.9	5.9	76.5
Motorcycle	2	11.8	11.8	88.2
HGV	1	5.9	5.9	94.1
HGV, PSV & Tracked	1	5.9	5.9	100.0
Total	17	100.0	100.0	

Valid cases 17 Missing cases 0

POINTS
Do you have any current penalty points on your licence?

Value	Frequency	Percent	Valid Percent	Cum Percent
No	14	82.4	82.4	82.4
Yes	3	17.6	17.6	100.0
Total	17	100.0	100.0	

Valid cases 17 Missing cases 0

TOTMGP
What was your total mileage over the last year?

Value	Frequency	Percent	Valid Percent	Cum Percent
<10,000	10	58.8	58.8	58.8
10,000-19,000	4	23.5	23.5	82.4
20,000-29,000	1	5.9	5.9	88.2
30,000-39,000	1	5.9	5.9	94.1
60,000-69,000	1	5.9	5.9	100.0
Total	17	100.0	100.0	

Valid cases 17 Missing cases 0

DRVFREQ
How often have you driven over the last year?

Value	Frequency	Percent	Valid Percent	Cum Percent
Daily	13	76.5	76.5	76.5
Several times a week	4	23.5	23.5	100.0
Total	17	100.0	100.0	

Valid cases 17 Missing cases 0

RURMILES
How often have you driven on rural A roads over the last year?

Value	Frequency	Percent	Valid Percent	Cum Percent
Daily	6	35.3	35.3	35.3
Several times a week	2	11.8	11.8	47.1
Several times a month	7	41.2	41.2	88.2
Less often than monthly	2	11.8	11.8	100.0
Total	17	100.0	100.0	

Valid cases 17 Missing cases 0

JOBDRIVE
How often do you drive as part of your job?

Value	Frequency	Percent	Valid Percent	Cum Percent

Never	9	52.9	52.9	52.9
Daily	3	17.6	17.6	70.6
Several times a week	1	5.9	5.9	76.5
Several times a month	1	5.9	5.9	82.4
Less often than monthly	3	17.6	17.6	100.0
Total	17	100.0	100.0	

Valid cases 17 Missing cases 0

C. GENERAL GROUP

AGEGROUP

Value	Frequency	Percent	Valid Percent	Cum Percent
18-19	1	5.3	5.3	5.3
20-29	8	42.1	42.1	47.4
30-39	4	21.1	21.1	68.4
40-49	3	15.8	15.8	84.2
50-59	1	5.3	5.3	89.5
60+	2	10.5	10.5	100.0
	-------	-------	-------	
Total	19	100.0	100.0	

Valid cases 19 Missing cases 0

AGEGRP

Value	Frequency	Percent	Valid Percent	Cum Percent
30+	10	52.6	52.6	52.6
<30	9	47.4	47.4	100.0
	-------	-------	-------	
Total	19	100.0	100.0	

Valid cases 19 Missing cases 0

SEX

Value	Frequency	Percent	Valid Percent	Cum Percent
Female	9	47.4	47.4	47.4
Male	10	52.6	52.6	100.0
	-------	-------	-------	
Total	19	100.0	100.0	

Valid cases 19 Missing cases 0

YRSREGGP

How many years have you been driving regularly?

Value	Frequency	Percent	Valid Percent	Cum Percent
1-4	4	21.1	21.1	21.1

5-9	5	26.3	26.3	47.4
10-14	6	31.6	31.6	78.9
15-24	1	5.3	5.3	84.2
25-34	2	10.5	10.5	94.7
35-44	1	5.3	5.3	100.0
	-------	-------	-------	
Total	19	100.0	100.0	

Valid cases 19 Missing cases 0

TESTNO
How many driving tests did you take?

Value	Frequency	Percent	Valid Percent	Cum Percent
1	7	36.8	36.8	36.8
2	9	47.4	47.4	84.2
3	2	10.5	10.5	94.7
5	1	5.3	5.3	100.0
Total	19	100.0	100.0	

Valid cases 19 Missing cases 0

TESTYPE
Have you passed any additional driving courese?

Value	Frequency	Percent	Valid Percent	Cum Percent
None	13	68.4	68.4	68.4
Advanced	2	10.5	10.5	78.9
Police	2	10.5	10.5	89.4
Minibus	1	5.3	5.3	94.7
HGV&PSV	1	5.3	5.3	100.0
Total	19	100.0	100.0	

Valid cases 19 Missing cases 0

POINTS
Do you have any current penalty points on you driving licence?

Value	Frequency	Percent	Valid Percent	Cum Percent
No	19	100.0	100.0	100.0
Total	19	100.0	100.0	

Valid cases 19 Missing cases 0

TOTMGP

Value	Frequency	Percent	Valid Percent	Cum Percent
<10,000	5	26.3	26.3	26.3
10,000-19,000	8	42.1	42.1	68.4
20,000-29,000	3	15.8	15.8	84.2
30,000-39,000	1	5.3	5.3	89.5
40,000-49,000	1	5.3	5.3	94.7
50,000-59,000	1	5.3	5.3	100.0
Total	19	100.0	100.0	

Valid cases 19 Missing cases 0

DRVFREQ

Value	Frequency	Percent	Valid Percent	Cum Percent
Daily	17	89.5	89.5	89.5
Several times a week	1	5.3	5.3	94.7
Less often than monthly	1	5.3	5.3	100.0
Total	19	100.0	100.0	

Valid cases 19 Missing cases 0

RURMILES

How often have you driven on rural A roads over the last year?

Value	Frequency	Percent	Valid Percent	Cum Percent
Daily	10	52.6	52.6	52.6
Several times a week	3	15.8	15.8	68.4
Several times a month	3	15.8	15.8	84.2
Less often than monthly	3	15.8	15.8	100.0
Total	19	100.0	100.0	

Valid cases 19 Missing cases 0

JOBDRIVE

How often do you drive as part of a job?

Value	Frequency	Percent	Valid Percent	Cum Percent
Never	9	47.4	47.4	47.4
Daily	8	42.1	42.1	89.5
Several times a week	1	5.3	5.3	94.7
Several times a month	1	5.3	5.3	100.0
	-------	-------	-------	
Total	19	100.0	100.0	

Valid cases 19 Missing cases 0

APPENDIX 4 - CROSSTABULATIONS OF QUESTIONNAIRE RESPONSES FOR PHASE ONE SUBJECTS BY AGE AND SEX

A. VILLAGES GROUP

SEX by AGEGROUP

SEX (Count)	AGEGROUP 20-29	30-39	40-49	50-59	60+	Row Total
Female	4	2	1	1	1	9 50.0
Male	4	2	1	1	1	9 50.0
Column Total	8 44.4	4 22.2	2 11.1	2 11.1	2 11.1	18 100.0

Number of Missing Observations: 0

SEX by AGEGRP

SEX (Count)	AGEGRP 30+	<30	Row Total
Female	5	4	9 50.0
Male	5	4	9 50.0
Column Total	10 55.6	8 44.4	18 100.0

Number of Missing Observations: 0

AGEGRP by YRSREGGP
Controlling for..
SEX Value = Female

YRSREGGP

Count

AGEGRP		1-4	5-9	10-14	15-24	25-34	Row Total
	30+			3	1	1	5 55.6
	<30	2	2				4 44.4
	Column Total	2 22.2	2 22.2	3 33.3	1 11.1	1 11.1	9 100.0

AGEGRP by YRSREGGP
Controlling for..
SEX Value = Male

AGEGRP	Count (YRSREGGP)	5-9	10-14	15-24	25-34	Row Total
	30+	1	2	1	1	5 55.6
	<30	1	3			4 44.4
	Column Total	2 22.2	5 55.6	1 11.1	1 11.1	9 100.0

Number of Missing Observations: 0

AGEGRP by TESTNO
Controlling for..
SEX Value = Female

AGEGRP	Count (TESTNO)	1	2	3	Row Total
	30+	2	2	1	5 55.6
	<30	1	1	2	4 44.4

Column Total	3 33.3	3 33.3	3 33.3	9 100.0

AGEGRP by TESTNO
Controlling for..
SEX Value = Male

AGEGRP \ TESTNO (Count)	1	2	3	Row Total
30+	1	1	3	5 55.6
<30	3	1		4 44.4
Column Total	4 44.4	2 22.2	3 33.3	9 100.0

Number of Missing Observations: 0

AGEGRP by TESTYPE
Controlling for..
SEX Value = Female

AGEGRP \ TESTYPE (Count)	None	Instrct.	Row Total
30+	4	1	5 55.6
<30	4		4 44.4
Column Total	8 88.9	1 11.1	9 100.0

AGEGRP by TESTYPE
Controlling for..
SEX Value = Male

AGEGRP	TESTYPE Count	None	Other	Row Total
	30+	4	1	5 55.6
	<30	3	1	4 44.4
	Column Total	7 77.8	2 22.2	9 100.0

Number of Missing Observations: 0

AGEGRP by POINTS
Controlling for..
SEX Value = Female

AGEGRP	POINTS Count	No	Yes	Row Total
	30+	4	1	5 55.6
	<30	4		4 44.4
	Column Total	8 88.9	1 11.1	9 100.0

AGEGRP by POINTS
Controlling for..
SEX Value = Male

AGEGRP	POINTS Count	No	Yes	Row Total
	30+	3	2	5 55.6
	<30	2	2	4 44.4
	Column Total	5 55.6	4 44.4	9 100.0

Number of Missing Observations: 0

AGEGRP by TOTMGP
Controlling for..
SEX Value = Female

TOTMGP: In 1,000s miles

AGEGRP	Count	<10	10-19	Row Total
	30+	4	1	5 55.6
	<30	2	2	4 44.4
	Column Total	6 66.7	3 33.3	9 100.0

AGEGRP by TOTMGP
Controlling for..
SEX Value = Male

TOTMGP: In 1,000s miles

	Count	<10	10-19	20-29	40-49	Row Total

AGEGRP						Row Total
	30+	1	2	1	1	5 55.6
	<30	1	2		1	4 44.4
	Column Total	2 22.2	4 44.4	1 11.1	2 22.2	9 100.0

Number of Missing Observations: 0

AGEGRP by DRVFREQ
Controlling for..
SEX Value = Female

DRVFREQ

AGEGRP	Count	Daily	Weekly	Monthly	Row Total
	30+	3	1	1	5 55.6
	<30	2	2		4 44.4
	Column Total	5 55.6	3 33.3	1 11.1	9 100.0

AGEGRP by DRVFREQ
Controlling for..
SEX Value = Male

DRVFREQ

AGEGRP	Count	Daily	Weekly	Row Total
	30+	4	1	5 55.6
	<30	3	1	4 44.4
	Column Total	7 77.8	2 22.2	9 100.0

Number of Missing Observations: 0

AGEGRP by RURMILES
Controlling for..
SEX Value = Female

AGEGRP (Count)	RURMILES: Daily	Weekly	Monthly	Row Total
30+		3	2	5 55.6
<30	3	1		4 44.4
Column Total	3 33.3	4 44.4	2 22.2	9 100.0

AGEGRP by RURMILES
Controlling for..
SEX Value = Male

RURMILES

AGEGRP (Count)	Daily	Weekly	Monthly	Row Total
30+	4	1		5 55.6
<30	1	2	1	4 44.4
Column Total	5 55.6	3 33.3	1 11.1	9 100.0

Number of Missing Observations: 0

AGEGRP by JOBDRIVE
Controlling for..
SEX Value = Female

JOBDRIVE

AGEGRP (Count)	Never	Weekly	<Monthly	Row Total
30+	4		1	5 55.6
<30	2	1	1	4 44.4
Column Total	6 66.7	1 11.1	2 22.2	9 100.0

AGEGRP by JOBDRIVE
Controlling for..
SEX Value = Male

JOBDRIVE

Count	Never	Daily	Weekly	Monthly	Row Total

AGEGRP					
30+	3		1	1	5 55.6
<30	3	1			4 44.4
Column Total	6 66.7	1 11.1	1 11.1	1 11.1	9 100.0

Number of Missing Observations: 0

B. BENDS GROUP

SEX by AGEGROUP

SEX	Count / AGEGROUP: 18-19	20-29	30-39	40-49	50-59	60+	Row Total
Female	1	3	2	1	1		8 47.1
Male	1	3	1	1	2	1	9 52.9
Column Total	2 11.8	6 35.3	3 17.6	2 11.8	3 17.6	1 5.9	17 100.0

Number of Missing Observations: 0

SEX by AGEGRP

SEX	Count / AGEGRP: 30+	<30	Row Total
Female	4	4	8 47.1
Male	5	4	9 52.9
Column Total	9 52.9	8 47.1	17 100.0

Number of Missing Observations: 0

AGEGRP by YRSREGGP
Controlling for..
SEX Value = Female

Count / YRSREGGP: <1yr	1-4	5-9	10-14	25-34	Row Total

AGEGRP						
30+			1	2	1	4 50.0
<30	2	1	1			4 50.0
Column Total	2 25.0	1 12.5	2 25.0	2 25.0	1 12.5	8 100.0

AGEGRP by YRSREGGP
Controlling for..
SEX Value = Male

AGEGRP (Count)	YRSREGGP 1-4	5-9	10-14	25-34	35-44	Row Total
30+			1	1	3	5 55.6
<30	2	2				4 44.4
Column Total	2 22.2	2 22.2	1 11.1	1 11.1	3 33.3	9 100.0

Number of Missing Observations: 0

AGEGRP by TESTNO
Controlling for..
SEX Value = Female

AGEGRP (Count)	TESTNO 1	2	3	Row Total
30+	2	1	1	4 50.0
<30	1	3		4 50.0
Column Total	3 38.0	4 50.0	1 12.5	8 100.0

AGEGRP by TESTNO
Controlling for..
SEX Value = Male

Count	TESTNO 1	2	3	Row Total

AGEGRP				
30+	4		1	5 55.6
<30	2	1	1	4 44.4
Column Total	6 66.7	1 11.1	2 22.2	9 100.0

Number of Missing Observations: 0

AGEGRP by TESTYPE
Controlling for..
SEX Value = Female

Count / AGEGRP	TESTYPE: None	Instrct.	Row Total
30+	3	1	4 50.0
<30	4		4 50.0
Column Total	7 87.5	1 12.5	8 100.0

AGEGRP by TESTYPE
Controlling for..
SEX Value = Male

Count / AGEGRP	TESTYPE: None	M/C	HGV	HGV/PSV/ Other	Row Total
30+	2	1	1	1	5 55.6
<30	3	1			4 44.4
Column Total	5 55.6	2 22.2	1 11.1	1 11.1	9 100.0

Number of Missing Observations: 0

AGEGRP by POINTS
Controlling for..
SEX Value = Female

AGEGRP	POINTS Count: No	Row Total
30+	4	4 50.0
<30	4	4 50.0
Column Total	8 100.0	8 100.0

AGEGRP by POINTS
Controlling for..
SEX Value = Male

AGEGRP (Count)	POINTS: No	Yes	Row Total
30+	4	1	5 55.6
<30	2	2	4 44.4
Column Total	6 66.7	3 33.3	9 100.0

Number of Missing Observations: 0

AGEGRP by TOTMGP
Controlling for..
SEX Value = Female

AGEGRP (Count)	TOTMGP In 1,000s miles: <10	10-19	Row Total
30+	2	2	4 50.0
<30	4		4 50.0
Column Total	6 75.0	2 25.0	8 100.0

AGEGRP by TOTMGP
Controlling for..
SEX Value = Male

Count	TOTMGP In 1,000s miles: <10	10-19	20-29	30-39	60-69	Row Total

AGEGRP						
30+	1	1	1	1	1	5 55.6
<30	3	1				4 44.4
Column Total	4 44.4	2 22.2	1 11.1	1 11.1	1 11.1	9 100.0

Number of Missing Observations: 0

AGEGRP by DRVFREQ
Controlling for..
SEX Value = Female

AGEGRP (Count)	DRVFREQ Daily	Weekly	Row Total
30+	3	1	4 50.0
<30	3	1	4 50.0
Column Total	6 75.0	2 25.0	8 100.0

AGEGRP by DRVFREQ
Controlling for..
SEX Value = Male

AGEGRP (Count)	DRVFREQ Daily	Weekly	Row Total
30+	5		5 55.6
<30	2	2	4 44.4
Column Total	7 77.8	2 22.2	9 100.0

Number of Missing Observations: 0

AGEGRP by RURMILES
Controlling for..
SEX Value = Female

AGEGRP (Count) by RURMILES	Daily	Weekly	Monthly	<Monthly	Row Total
30+	1		1	2	4 50.0
<30		1	3		4 50.0
Column Total	1 12.5	1 12.5	4 50.0	2 25.0	8 100.0

AGEGRP by RURMILES
Controlling for..
SEX Value = Male

RURMILES

Count	Daily	Weekly	Monthly	Row Total
AGEGRP				
30+	5			5 55.6
<30		1	3	4 44.4
Column Total	5 55.6	1 11.1	3 33.3	9 100.0

Number of Missing Observations: 0

AGEGRP by JOBDRIVE
Controlling for..
SEX Value = Female

JOBDRIVE

Count	Never	<Monthly	Row Total
AGEGRP			
30+	3	1	4 50.0
1.0	3	1	4 50.0
Column Total	6 75.0	2 25.0	8 100.0

AGEGRP by JOBDRIVE
Controlling for..
SEX Value = Male

JOBDRIVE

Count	Never	Daily	Weekly	Monthly	<Monthly	Row Total

AGEGRP

30+	1	2		1	1	5 55.6
<30	2	1	1			4 44.4
Column Total	3 33.3	3 33.3	1 11.1	1 11.1	1 11.1	9 100.0

Number of Missing Observations: 0

C. GENERAL GROUP

SEX by AGEGROUP

SEX (Count) / AGEGROUP	18-19	20-29	30-39	40-49	50-59	60+	Row Total
30+		5	1	2		1	9 47.4
<30	1	3	3	1	1	1	10 52.6
Column Total	1 5.3	8 42.1	4 21.1	3 15.8	1 5.3	2 10.5	19 100.0

Number of Missing Observations: 0

SEX by AGEGRP

SEX (Count) / AGEGRP	30+	<30	Row Total
30+	4	5	9 47.4
<30	6	4	10 52.6
Column Total	10 52.6	9 47.4	19 100.0

Number of Missing Observations: 0

AGEGRP by YRSREGGP
Controlling for..
SEX Value = Female

Count / YRSREGGP	1-4	5-9	10-14	25-34	Row Total

AGEGRP						
	30+	1		2	1	4 44.4
	<30	2	2	1		5 55.6
	Column Total	3 33.3	2 22.2	3 33.3	1 11.1	9 100.0

AGEGRP by YRSREGGP
Controlling for..
SEX Value = Male

YRSREGGP

AGEGRP / Count	1-4	5-9	10-14	15-24	25-34	35-44	Row Total
30+		2	1	1	1	1	6 60.0
<30	1	1	2				4 40.0
Column Total	1 10.0	3 30.0	3 30.0	1 10.0	1 10.0	1 10.0	10 100.0

Number of Missing Observations: 0

AGEGRP by TESTNO
Controlling for..
SEX Value = Female

TESTNO

AGEGRP / Count	1	2	3	5	Row Total
30+	1	2		1	4 44.4
<30		4	1		5 55.6
Column Total	1 11.1	6 66.7	1 11.1	1 11.1	9 100.0

AGEGRP by TESTNO
Controlling for..
SEX Value = Male

TESTNO

Count	1	2	3	Row Total

AGEGRP				Row Total
30+	3	2	1	6 60.0
<30	3	1		4 40.0
Column Total	6 60.0	3 30.0	1 10.0	10 100.0

Number of Missing Observations: 0

AGEGRP by TESTYPE
Controlling for..
SEX Value = Female

AGEGRP (Count)	TESTYPE: None	Other	Row Total
30+	4		4 44.4
<30	4	1	5 55.6
Column Total	8 88.9	1 11.1	9 100.0

AGEGRP by TESTYPE
Controlling for..
SEX Value = Male

AGEGRP (Count)	TESTYPE: None	Advanced	Other	HGV/PSV	Row Total
30+	3	1	1	1	6 60.0
<30	2	1	1		4 40.0
Column Total	5 50.0	2 20.0	2 20.0	1 10.0	10 100.0

Number of Missing Observations: 0

AGEGRP by POINTS
Controlling for..
SEX Value = Female

AGEGRP	POINTS Count: No	Row Total
30+	4	4 44.4
<30	5	5 55.6
Column Total	9 100.0	9 100.0

AGEGRP by POINTS
Controlling for..
SEX Value = Male

AGEGRP	POINTS Count: No	Row Total
30+	6	6 60.0
<30	4	4 40.0
Column Total	10 100.0	10 100.0

Number of Missing Observations: 0

AGEGRP by TOTMGP
Controlling for..
SEX Value = Female

TOTMGP: In 1,000s miles

AGEGRP (Count)	<10	10-19	20-29	Row Total
30+	1	2	1	4 44.4
<30	3	2		5 55.6
Column Total	4 44.4	4 44.4	1 11.1	9 100.0

AGEGRP by TOTMGP
Controlling for..
SEX Value = Male

TOTMGP: In 1,000s miles

Count	<10	10-19	20-29	30-39	40-49	50-59	Row Total

AGEGRP							
30+	1	2	1	1		1	6 60.0
<30		2	1		1		4 40.0
Column Total	1 10.0	4 40.0	2 20.0	1 10.0	1 10.0	1 10.0	10 100.0

AGEGRP by DRVFREQ
Controlling for..
SEX Value = Female

DRVFREQ

AGEGRP Count	Daily	Weekly	<Monthly	Row Total
30+	4			4 44.4
<30	3	1	1	5 55.6
Column Total	7 77.8	1 11.1	1 11.1	9 100.0

AGEGRP by DRVFREQ
Controlling for..
SEX Value = Male

DRVFREQ

AGEGRP Count	Daily	Row Total
30+	6	6 60.0
<30	4	4 40.0
Column Total	10 100.0	10 100.0

Number of Missing Observations: 0

AGEGRP by RURMILES
Controlling for..
SEX Value = Female

RURMILES

Count	Daily	Weekly	Monthly	<Monthly	Row Total

AGEGRP					
30+	1	1	1	1	4 44.4
<30	3			2	5 55.6
Column Total	4 44.4	1 11.1	1 11.1	3 33.3	9 100.0

AGEGRP by RURMILES
Controlling for..
SEX Value = Male

AGEGRP (Count)	RURMILES: Daily	Weekly	Monthly	Row Total
30+	4	1	1	6 60.0
<30	2	1	1	4 40.0
Column Total	6 60.0	2 20.0	2 20.0	10 100.0

Number of Missing Observations: 0

AGEGRP by JOBDRIVE
Controlling for..
SEX Value = Female

AGEGRP (Count)	JOBDRIVE: Never	Daily	Row Total
30+	2	2	4 44.4
<30	5		5 55.6
Column Total	7 77.8	2 22.2	9 100.0

AGEGRP by JOBDRIVE
Controlling for..
SEX Value = Male

Count	JOBDRIVE: Never	Daily	Weekly	Monthly	Row Total

AGEGRP					
30+	1	4		1	6 60.0
<30	1	2	1		4 40.0
Column Total	2 20.0	6 60.0	1 10.0	1 10.0	10 100.0

Number of Missing Observations: 0

APPENDIX 5 – FREQUENCIES OF QUESTIONNAIRE RESPONSES FOR PHASE TWO SUBJECTS

AGEGROUP

Value	Frequency	Percent	Valid Percent	Cum Percent
20-29	8	44.4	44.4	44.4
30-39	4	22.2	22.2	66.7
40-49	2	11.1	11.1	77.8
50-59	2	11.1	11.1	88.9
60-69	2	11.1	11.1	100.0
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

AGEGRP

Value	Frequency	Percent	Valid Percent	Cum Percent
30+	10	55.6	55.6	55.6
<30	8	44.4	44.4	100.0
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

SEX

Value	Frequency	Percent	Valid Percent	Cum Percent
Female	9	50.0	50.0	50.0
Male	9	50.0	50.0	100.0
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

YRSREGGP

How many years have you been driving regularly?

Value	Frequency	Percent	Valid Percent	Cum Percent
<1yr	1	5.6	5.6	5.6

1-4	3	16.7	16.7	22.2
5-9	4	22.2	22.2	44.4
10-14	6	33.3	33.3	77.8
15-24	2	11.1	11.1	88.9
25-34	1	5.6	5.6	94.4
35-44	1	5.6	5.6	100.0
	-------	-------	-------	
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

TESTNO

How many driving tests did you take?

Value	Frequency	Percent	Valid Percent	Cum Percent
1	7	38.9	38.9	38.9
2	7	38.9	38.9	77.8
3	4	22.2	22.2	100.0
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

TESTYPE

Have you passed any additional driving courses?

Value	Frequency	Percent	Valid Percent	Cum Percent
None	14	77.8	77.8	77.8
Instructors	1	5.6	5.6	83.3
M/C	2	11.1	11.1	94.4
Other	1	5.6	5.6	100.0
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

POINTS

Do you have any current penalty points on your licence?

Value	Frequency	Percent	Valid Percent	Cum Percent
No	12	66.7	66.7	66.7
Yes	6	33.3	33.3	100.0
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

TOTMGP

What was your total mileage over the last year?

Valid Cum

Value	Frequency	Percent	Percent	Percent
<10,000	9	50.0	50.0	50.0
10,000-19,000	6	33.3	33.3	83.3
20,000-29,000	1	5.6	5.6	88.9
30,000-39,000	1	5.6	5.6	94.4
40,000-49,000	1	5.6	5.6	100.0
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

DRVFREQ

How often have you driven over the last year?

Value	Frequency	Percent	Valid Percent	Cum Percent
Daily	11	61.1	61.1	61.1
Several times a week	6	33.3	33.3	94.4
Several times a month	1	5.6	5.6	100.0
	-------	-------	-------	
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

RURMILES

How often have you driven on rural roads over the last year?

Value	Frequency	Percent	Valid Percent	Cum Percent
Daily	6	33.3	33.3	33.3
Several times a week	4	22.2	22.2	55.6
Several times a month	6	33.3	33.3	88.9
Less often than monthly	2	11.1	11.1	100.0
	-------	-------	-------	
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

JOBDRIVE

How often do you drive as part of a job?

Value	Frequency	Percent	Valid Percent	Cum Percent
Never	9	50.0	50.0	50.0
Daily	2	11.1	11.1	61.1
Several times a week	2	11.1	11.1	72.2
Several times a month	1	5.6	5.6	77.8
Less often than monthly	4	22.2	22.2	100.0
	-------	-------	-------	
Total	18	100.0	100.0	

Valid cases 18 Missing cases 0

APPENDIX 6 – CROSSTABULATIONS OF QUESTIONNAIRE RESPONSES FOR PHASE TWO SUBJECTS BY AGE AND SEX

SEX by AGEGROUP

SEX / Count	AGEGROUP 20-29	30-39	40-49	50-59	60+	Row Total
Female	4	2	1	1	1	9 50.0
Male	4	2	1	1	1	9 50.0
Column Total	8 44.4	4 22.2	2 11.1	2 11.1	2 11.1	18 100.0

Number of Missing Observations: 0

SEX by AGEGRP

SEX / Count	AGEGRP 30+	<30	Row Total
Female	5	4	9 50.0
Male	5	4	9 50.0
Column Total	10 55.6	8 44.4	18 100.0

Number of Missing Observations: 0

AGEGRP by YRSREGGP
Controlling for..
SEX Value = Female

YRSREGGP
Count

Row

AGEGRP	<1	1-4	5-9	10-14	15-24	25-34	Total
30+			1	2	1	1	5 55.6
<30	1	2	1				4 44.4
Column Total	1 11.1	2 22.2	2 22.2	2 22.2	1 11.1	1 11.1	9 100.0

AGEGRP by YRSREGGP
Controlling for..
SEX Value = Male

YRSREGGP

Count						
AGEGRP	1-4	5-9	10-14	15-24	35-44	Row Total
30+		1	2	1	1	5 55.6
<30	1	1	2			4 44.4
Column Total	1 11.1	2 22.2	4 44.4	1 11.1	1 11.1	9 100.0

Number of Missing Observations: 0

AGEGRP by TESTNO
Controlling for..
SEX Value = Female

TESTNO

Count				
AGEGRP	1	2	3	Row Total
30+	2	2	1	5 55.6
<30	1	3		4 44.4
Column Total	3 33.3	5 55.6	1 11.1	9 100.0

AGEGRP by TESTNO
Controlling for..
SEX Value = Male

TESTNO

Count				
	1	2	3	Row Total

AGEGRP

30+	1	1	3	5 55.6
<30	3	1		4 44.4
Column Total	4 44.4	2 22.2	3 33.3	9 100.0

Number of Missing Observations: 0

AGEGRP by TESTYPE
Controlling for..
SEX Value = Female

AGEGRP (Count)	TESTYPE: None	Instruct	Row Total
30+	4	1	5 55.6
<30	4		4 44.4
Column Total	8 88.9	1 11.1	9 100.0

AGEGRP by TESTYPE
Controlling for..
SEX Value = Male

AGEGRP (Count)	TESTYPE: None	M/C	Other	Row Total
30+	3	1	1	5 55.6
<30	3	1		4 44.4
Column Total	6 66.7	2 22.2	1 11.1	9 100.0

Number of Missing Observations: 0

AGEGRP by POINTS
Controlling for..
SEX Value = Female

Count	POINTS: No	Yes	Row Total

AGEGRP				
	30+	4	1	5 55.6
	<30	4		4 44.4
	Column Total	8 88.9	1 11.1	9 100.0

AGEGRP by POINTS
Controlling for..
SEX Value = Male

AGEGRP	POINTS Count: No	Yes	Row Total
30+	3	2	5 55.6
<30	1	3	4 44.4
Column Total	4 44.4	5 55.6	9 100.0

Number of Missing Observations: 0

AGEGRP by TOTMGP
Controlling for..
SEX Value = Female

AGEGRP	TOTMGP Count (In 1,000s miles): <10	10-19	Row Total
30+	3	2	5 55.6
<30	3	1	4 44.4
Column Total	6 66.7	3 33.3	9 100.0

AGEGRP by TOTMGP
Controlling for..
SEX Value = Male

TOTMGP Count (In 1,000s miles): <10	10-19	20-29	30-39	40-49	Row Total

AGEGRP						
30+	1	2	1	1		5 55.6
<30	2	1			1	4 44.4
Column Total	3 33.3	3 33.3	1 11.1	1 11.1	1 11.1	9 100.0

Number of Missing Observations: 0

AGEGRP by DRVFREQ
Controlling for..
SEX Value = Female

AGEGRP	Count (DRVFREQ)	Daily	Weekly	Monthly	Row Total
	30+	3	1	1	5 55.6
	<30	2	2		4 44.4
	Column Total	5 55.6	3 33.3	1 11.1	9 100.0

AGEGRP by DRVFREQ
Controlling for..
SEX Value = Male

AGEGRP	Count (DRVFREQ)	Daily	Weekly	Row Total
	30+	4	1	5 55.6
	<30	2	2	4 44.4
	Column Total	6 66.7	3 33.3	9 100.0

Number of Missing Observations: 0

AGEGRP by RURMILES
Controlling for..
SEX Value = Female

RURMILES Page 1 of 1

Count	Daily	Weekly	Monthly	<Monthly	Row Total

AGEGRP					
30+	1		2	2	5 55.6
<30		2	2		4 44.4
Column Total	1 11.1	2 22.2	4 44.4	2 22.2	9 100.0

AGEGRP by RURMILES
Controlling for..
SEX Value = Male

AGEGRP (Count)	RURMILES: Daily	Weekly	Monthly	Row Total
30+	4	1		5 55.6
<30	1	1	2	4 44.4
Column Total	5 55.6	2 22.2	2 22.2	9 100.0

Number of Missing Observations: 0

AGEGRP by JOBDRIVE
Controlling for..
SEX Value = Female

AGEGRP (Count)	JOBDRIVE: Never	Weekly	<Monthly	Row Total
30+	4		1	5 55.6
<30	1	1	2	4 44.4
Column Total	5 55.6	1 11.1	3 33.3	9 100.0

AGEGRP by JOBDRIVE
Controlling for..
SEX Value = Male

Count	JOBDRIVE: Never	Daily	Weekly	Monthly	<Monthly	Row Total

AGEGRP						
30+	3			1	1	5 55.6
<30	1	2	1			4 44.4
Column Total	4 44.4	2 22.2	1 11.1	1 11.1	1 11.1	9 100.0

Number of Missing Observations: 0

APPENDIX 7 - KEY TO VARIABLE NAMES

Village treatments

VSAMEANMean speed at the start of the village (point A) (mph).
VSAV8585th percentile speed at the start of the village (mph).
VSAV2525th percentile speed (lower quartile) at the start of the village (mph).
VSAV5050th percentile speed (median) at the start of the village (mph).
VSAV7575th percentile speed (upper quartile) at the start of the village (mph).
VSAVARSpeed variance a the start of the village (mph).
VSASKWSkew of the speed distribution at the start of the village.

A *B* or *C* as the third character of the variable name indicates the same statistic but measured at the middle or end of the village.
An *R* in front of any variable name indicates the rank of that variable.

VILL_1RVS_MEAN + RVS_V85 + RVS_VAR
VILL_2RVS_MEAN + RVS_V85

Bend treatments

CSXMEAN Mean speed at the curve entry point (point X)(mph).
CSXV85 85th percentile speed at the curve entry point (mph).
CSXV25 25th percentile speed (lower quartile) at the curve entry point (mph).
CSXV50 50th percentile speed (median) at the curve entry point (mph).
CSXV75 75th percentile speed (upper quartile) at the curve entry point (mph).
CSXVAR Speed variance a the curve entry point (mph).
CSXSKW1 Skew of the speed distribution at the curve entry point.
CSXSKW2 Magnitude of the skew of the speed distribution at the curve entry point.
CLRMEAN Mean of the range of lateral position for points X, Y and Z (m).

BENDS1 RCSXMEAN + RCSXV85 + RCSXVAR
BENDS2 RCSXMEAN + RCSXV85 + RCLRMEAN
BENDS3 RCSXMEAN + RCSXV85

An *R* in front of any variable name indicates the rank of that variable.

General treatments

The data for which the following statistics were calculated was the mean of 60 speed or lateral position values measured at 5m intervals over a 300m stretch of road, for each subject and each treatment.

GSMEAN Mean of mean speed (mph).
GSV85 85th percentile of mean speed (mph).
GSV25 25th percentile of mean speed (lower quartile) (mph).
GSV50 50th percentile of mean speed (median) (mph).
GSV75 75th percentile of mean speed (upper quartile) (mph).
GSVAR Variance of mean speed (mph).
GSSKW1 Skew of the distribution of mean speeds.
GSSKW2 Magnitude of the skew of the distribution of mean speeds.

GLMEAN   Mean of the mean lateral position (m).

GENERL1 RGSMEAN + RGSV85 + RGSVAR + RGLMEAN
GENERL2 RGSMEAN + RGSV85 + RGSVAR
GENERL3 RGSMEAN + RGSV85 + RGLMEAN
GENERL4 RGSMEAN + RGSV85

An *R* in front of any variable name indicates the rank of that variable.