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SPECIAL REPORT

PERS 87.

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Research Registry

A Literature Survey and Evaluation.

NATIONAL INSTITUTE FOR PERSONNEL RESEARCH
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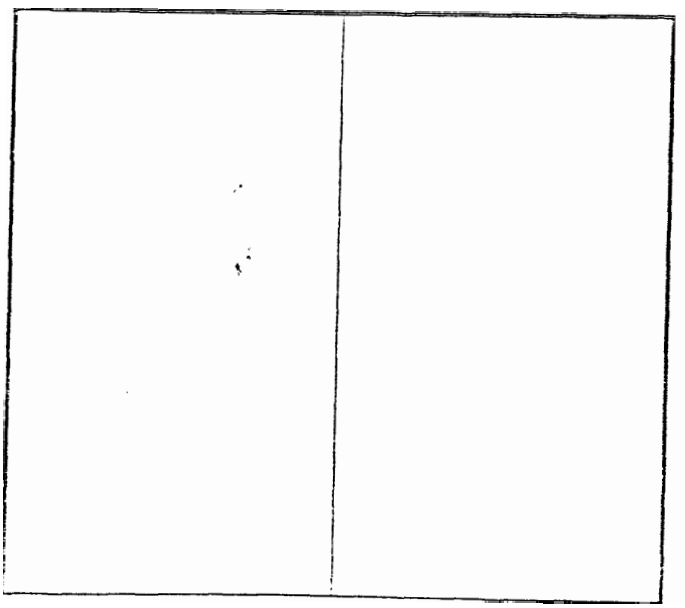

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BY

F. A. VERWEY and C. R. THOMSON

Johannesburg. 17th May, 1966.

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C O N T E N T S

rights and of his responsibilities as a road user, and in determining the extent of his appreciation of the reasons behind imposed controls of any kind. (pp. 38 and 39.)

(b) Preventive Measures

4. The introduction of courses by which an advanced driving licence could be obtained. (p. 39)

5. The keeping of individual accident records for all car drivers. (p. 39)

6. The enlistment of all forms of mass media to educate the public on road safety and to direct their attention to its importance. This should be directed primarily at the parents of young and adolescent children, and at sick and elderly people to make them conscious of their possible weaknesses. (p. 40)

II. GENERAL CONCLUSIONS DRAWN FROM THE LITERATURE

1. That an accident is the result of the interaction of many variables, and should be viewed as a whole. (p. 28)

2. That a central concept or framework is necessary for the study of accidents. (p. 28)

3. That accident data upon which research conclusions are based are too frequently of an unreliable nature. (p. 28)

4. That an interdisciplinary approach to the problem of road accident research is necessary. (p. 29)

5. The need for "Control" Groups when making studies of Accident Repeaters. (p. 29)

6. That the extent to which many factors are causative in road accidents has not so far been clearly established. A list of these, together with a list of those for which the conclusions are definite or strongly suggestive, is given on pages 29 and 30.

7. That there are many measures not yet applied, by which the risk of motor accidents for all types of road user could be reduced. These are outlined on pages 30 - 34.

B. INTRODUCTION /...

B. INTRODUCTION

In reviewing the literature on the road safety problem, one is struck by the fact that almost every writer finds it incumbent upon him to stress the magnitude and seriousness of the problem and to dwell on the horrifying mortality and morbidity statistics relating to traffic accidents.

In contrast with the attitude towards prevention of disease held both by the general public and by governing bodies, it would appear that a curious apathy exists in the mind of modern man towards this cause of continually increasing mortality in the human race. There are few, if any, people today who accept tuberculosis as a natural concomitant of the industrial way of life, yet in a paper delivered at a recent conference (30) sponsored by the British Medical Association, the Royal College of Surgeons and Associations of Motor Traders, one medical man commented on the fact that the public had become "indifferent to statistics" (on motor accidents), and tended to "accept death and mutiliation as the inevitable price to be paid for rapid modern transport".

A prolonged and vigorous attack on this attitude of defeatism and casual acceptance is called for. This should be aimed at the individual, but it should also be directed where it would be most effective, namely at those public bodies which have the power to influence public opinion by propaganda, to control activities by restrictive measures, and finally to finance research on a large scale.

C. SOURCES OF INFORMATION AND METHOD OF REPORTING

I. SOURCES OF INFORMATION

The discussion below is based mainly on five major reviews of literature on accident and road safety research, (10,13,23,27,34) A wide area has been covered by these reviews. Publications of all descriptions (statistical, critical, uncontrolled observations, field and laboratory studies) are included. The references from the review of McFarland et al (23) alone number 1031.

Comments and conclusions from a recently published book, "Accident Research" (15), have also been taken into account in our summing up. In addition, reference is made to a number of individual studies.

The results of research (insofar as the publications reviewed to date are concerned) appear to be relatively meagre, when one considers the vast quantities of literature available.

II. REPORTING ON REVIEWS AND INDIVIDUAL ARTICLES

In reporting on the reviews and articles mentioned above, it was felt that the information which might be of greatest interest to us could best be presented under three following headings:

(a) Causative Factors in Motor Accidents. (Section D) with some comments on the consensus of reviewers' opinions at to the results of research on these factors.

(b) Methods by which Data have been Collected. (Section E) with comments and criticisms and some illustrative examples.

(c) Conclusions and Recommendations. (Section F) These will include, inter alia, suggestions for preventive measures and suggestions for further research.

D. CAUSATIVE/...

D. CAUSATIVE FACTORS

It seems that a good case can be made out for the application of the epidemiological model in the investigation of road accidents. Epidemiology, as a method of medical research, can be defined as a means of identifying, and reducing to some sort of roder, the multiplicity of factors associated with the incidence of certain diseases. It is claimed that accidents as a health problem conform to the same biologic laws as do disease processes, and that research into accidents can profitably be approached from the same standpoint. McFarland et al consider that these techniques offer "considerable promise" (23, p.15); L.G. Norman refers to them as "especially appropriate for the study of road traffic accidents because so many variables are involved in their causation" (27, p.19); and Haddon et al, though they do recognise the problems involved in its use as a conceptual framework, recommend it as a "practically useful device for at least approaching the entire field" (of accidents) (15, p.15).

This approach, moreover, does not seem to conflict with other approaches such as the systems idea, which sees the driver as part of a larger system, of which the vehicle and the road are other major components.

The epidemiology of accidents is discussed at length in an article by Gordon (14). The concept has broader application than merely to road accidents, and its exponents advocate it as a framework within which research can be carried out on any type of accident. Gordon talks of the "host" (the person involved) the "agent" or means by which the damaging element is introduced, and the environment in which host and agent find themselves. He refers to the "mechanism of accident production" as "the process by which the three components interact to produce a result". Bearing in mind the emphasis on multiplicity of causes and on their interaction, which is implicit in the epidemiological concept, it is under these three headings, host factors, agent factors and environmental factors, that we propose to discuss research findings regarding the causation of road accidents.

I. HOST/...

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I. HOST FACTORS

1. Personality Structure

According to McFarland, Moore and Warren (23, p.100) "no single characteristic of drivers has been isolated as outstanding in accounting for a large proportion of accidents on the highway". They go on to say: "Those attributes of drivers bearing a gross statistical relationship to accident frequencies include ..... a personality make-up in which social responsibility is weak or lacking". Dunlap and associates describe the personality of the probably accident maker as "eccentric, impulsive or mildly psychopathic" (10, p.iv). Walbeehm (34) quotes many studies in which characteristics of the accident repeater have been listed, but warns investigators (pp. 54, 55) of the danger of attributing certain personality factors to the "accident-repeater" without reference to a control group of "non-accident-repeaters". For example, he cites an investigation by Tillman & Hobbs, carried out with a sample of 100 "accident-repeaters", in which "60% appeared to be socially maladjusted and emotionally unbalanced". The investigators go on to say: "When, however, two groups of motorists who had never yet been involved in an accident were subsequently examined, it appeared that as many as 90% were socially maladjusted and emotionally unbalanced". Walbeehm concludes, from the investigations he has studied, that the accident-free compare favourably with the accident repeaters in various respects, including personality structure, and that "psychological causes can indeed be co-active". (p. 54)

Goldstein (13) who reviewed 11 studies on driving behaviour variables, states that it appears that "most accidents are first accidents on record", and that "it is not the few with extremely deviant behaviour which account for the major portion of the problem" (13, p.2). This raises a point often stressed by those who favour the systems approach

to accident/...

to accident research, namely: Are the demands made by modern vehicles and present conditions on the roads too great for the psychological (or psycho-physiological) capacities or "normal" people?

It would seem that the study of personality factors leaves us in rather a void. In other words: "Where do we go from here?" Assuming that we know that certain personality types are more likely to have accidents than others (and this, so far as we can establish, has not been proved conclusively, with comparable samples and under controlled conditions) is there anything we can do about this particular aspect of the problem? Can we refuse driving rights to certain individuals, on the grounds of failure to pass certain psychological tests? Furthermore, have we got the requisite number of qualified people to carry out such tests?

We can only agree with Walbeehm's conclusion that "under present circumstances, the psychological examination of drivers can only be a limited contribution to the solving of the entire accident problem" (34, p.57).

2. Psycho-physical, Biological, Personal History Factors

With regard to the psycho-physical aspects of the problem, Goldstein (13, p.5) makes very little claim for the success of visual, psychomotor, etc. tests, as predictors of accident tendency in drivers. Dunlap and associates say that "in general, the results .... are too meagre and conflicting to warrant placing much confidence in them" (10,p.5).

(a) Visual Acuity is a particularly important factor, about which little seems to be known. It seems, however, to be pretty generally agreed that colour blindness is not a great handicap. The difficulties of the one-eyed driver are mentioned by Walbeehm (34) and Norman (27). Light/dark adaptation and the effect of dazzle have received some attention. Sichel (31) refers to adaptation difficulty as "the most dangerous of all visual defects", and this

appears/...

appears to have particular relevance where the elderly driver is concerned (21). Sensitivity to glare is, according to Walbeehm (34, p.64) "not a constant factor, but a phenomenon which is subject to rather great fluctuations". He states that one cause of this, about which there is no difference of opinion is vitamin A deficiency, particularly noticeable during the winter months.

(b) Deafness is, according to Norman (27) a handicap to pedestrians but not to drivers, and other reviewers appear to be in agreement with this conclusion.

(c) Diseases. Where disease of any kind is concerned (epilepsy, diabetes, etc.) little appears to be known as to what contribution these factors make in accident causation.

(d) Intelligence. From 14 studies on cognitive measures reported by Goldstein, the results appear to have been conflicting (13, p.3)

(e) Age. On the subject of age, and its relationship to accident statistics, much has been written, and many claims made regarding the age groups responsible for the great majority of accidents. Here again there appear to be conflicting opinions. Goldstein (13) rates it high as a causative factor, including it as one of the three A's (Age, Attitudes, Alcohol) worthy of closer examination. Indeed, many studies have shown that the age groups showing highest accident rates are at the extreme ends of the age scale.

(i) Youthful Drivers

The California State Department (8), in a study whose object was to discover, if possible, the characteristics of negligent drivers found the median age of these to be 26.5 yrs. (against a general population median age of 39.1 yrs.)

Biesheuvel (3) found the peak period for motor cycle accidents to be between 25 and 29 years. Kaestner (19), referring to the fatal accident group, reports these to be significantly younger. The fact that a certain insurance group (16) applied its psychological inventory only to male drivers under 25, and that two groups of underwriters (18) favour the over 30's when fixing premium rates, adds weight to the assertion that youthful drivers are not a very good risk. Walbeehm (34) and Norman (27) concede the fact that statistical findings on youth and accidents cannot be denied, but criticise studies on youthful drivers on the grounds that they have been conducted without taking into account the experience variable.

(ii) Older Drivers

It is the disabilities of ageing that render older drivers more liable to accidents, but to offset these disabilities there are such factors as experience and mature thinking to be considered. Pim (28) says: "The important yardstick is not the chronological age but the functional age of an individual", and only periodic medical examination could cover this aspect of the problem. Lawton (21) speaks of visual deterioration in the ageing driver (particularly affecting night driving), and Sichel (31) in 1950, had quite a lot to say on this matter. Munden (26), however, from a social survey conducted in the U.K., reports that the older age-groups seem to be safer than has hitherto been thought. We might sum up by saying that it is youth, or the characteristics of youth (where these persist into later life), and age with its disabilities (where these have not been recognized and appropriate steps taken), that contribute to some extent in the causation of accidents.

(f) Marital Status. In most studies it is agreed that marriage seems to bring an increase in sense of responsibility and consequently a safer attitude towards driving. Broken marriage, of course, could have detrimental effects. The influence of insecurity in the home background, one cause of which could be impending divorce or general friction at home, is discussed below (paragraph 3a)

(g) Sex/...

(g) Sex. According to Walbeehm "nothing has yet been proved" (34, p.94) regarding the difference in accident tendency between men and women. Norman, however, (27, p.29) reports that in all countries traffic fatalities are 3-5 times higher for males than for females. The findings from some of the individual studies we have consulted confirm this latter statement (8, 19, 20), but there is some criticism by Haddon et al (15, p.130) of the methodology adopted by Lauer (20). One is perhaps nearer the truth in accepting Walbeehm's conclusion.

3. Temporary States

(a) Depression, Agression, Anti-Social Feelings

In a later section, headed "accident-proneness", reference will be made to the fact that in this respect, individuals can display great variability. One therefore feels justified in regarding a state of depression, or an aggressive mood as temporary and capable of being experienced in varying degrees by anybody at one time or another.
A broken marriage or general insecurity of home background could induce these states, in some cases rendering them relatively permanent. A passing phase, such as undue pressure of work could cause them to develop incidentally or for shorter periods.
A recent newspaper article reports the work of investigators who claim that many road accidents are virtually acts of murder or suicide committed by persons having suicidal or homicidal tendencies. These tendencies could of course be either temporary, permanent, or relatively permanent. McFarland et al (23, p.41) refer to a number of studies in which "biographical data related to anti-social trends or inadequate reactions" were considered in relation to accident frequency and recommends the use of such objective data in studying what appear to be personality factors. In our reading, we have come across a study by

Barmack and Payne (1), in which conclusions are drawn along similar lines, with special reference to the use of alcohol as a "tranquilliser" in stress situations arising out of some sort of disruption in the home background.

(b) Alcohol

Whether used, as indicated above, during a temporary mood state, continuously as in the case of an alcoholic, or to satisfy social or other needs, research has shown that "alcohol has a deleterious effect on behaviour at a much lower blood level concentration than is generally realised" (13, p.6). The studies reviewed by Walbeehm and McFarland et al confirm this finding, but both of these reviews comment on the fact that accident statistics do not give a clear insight into the extent to which alcohol is a causative factor in road accidents. (It would be interesting to know how controls in this respect operating in the United Kingdom and elsewhere would be received in this country.) This will be discussed in paragraph 4 below (Attitudes), and in Section F under Conclusions and Recommendations.

(c) Drugs and Medicaments

It is obvious that heavy consumption of narcotic or hypnotic drugs will render any road user unsafe on the roads. What is not so widely recognized - and this fact is stressed (and reference to studies made) in both of the more comprehensive reviews we have studied - is that prescribed or even self-administered ("over-the-counter") medicaments can have adverse effects of relatively long duration. Walbeehm (34), Norman (27) and McFarland et al (23) all call attention to the medical practitioner's responsibility in this connection.

(d) Fatigue

Crawford (9) reviews some of the research on operational fatigue and discusses the source of fatigue in driving.

He/...

He draws the following conclusions from 8 studies on driving:

(i) there is a decrease in psychomotor performance with the number of hours driven;

(ii) frequent pauses reduce deterioration; and

(iii) with every hour's progress in the trip, the number of near accidents decreases.

He also discusses the sources of fatigue (inter alia "serial or continuous tasks", among which one could include driving for long periods in darkness or on monotonous roads), and suggests some methods of measuring stress fatigue.

The three reviewers to whom we have made most frequent reference (i.e. Norman, Walbeehm, McFarland et al) do not come forward with very definite conclusions. Norman says: "Direct evidence about fatigue from motor vehicle driving is very limited." (27, p.55) Walbeehm concludes that "fatigue, as an accident factor, can be determined by all kinds of causes lying in the field of individual responsibility, as well as in the nature and extent of the task to be performed, and, to a not inconsiderable degree, in the driver's attitude towards his driving environment, the road and the vehicle" (34, p.96). He quotes a study carried out by two German investigators who conclude "that every driver feels fatigue coming on and that therefore he need not necessarily get involved in traffic accidents, if only he takes appropriate measures". McFarland et al (23) mention the difficulty of measuring the influence of fatigue on highway accidents, and go on to say that the traditional ways in which fatigue has been investigated have little relevance to the driving situation. They suggest that the analysis of operational errors in protracted driving may be more revealing and consider that the concept of "skill fatigue", developed originally in relation to aviation, could

provide/...

provide a framework for the carrying out of investigations of this nature (23, pp.44, 45).

4. Attitudes

Many attitudes are peculiar to an individual himself. They may arise, for example, by reason of his temperament, his age ("significantly related to attitudes" (13, p.4)), or from his addiction to alcohol. It is felt, however, that since most attitudes are formed within a person's social and cultural environment, this is the context in which this subject should be discussed, i.e. under "Environmental Factors", Section III below.

5. Accident Proneness

McFarland et al (23, Chs. III and IV) claim that preoccupation with the concept of accident-proneness is one of the reasons for the inadequacy of research to date. He feels that this area of research represents only a relatively small portion of the field. He proposes a less prejudiced term for this type of person, i.e. "accident repeater" rather than "accident-prone person", and goes on to say "the study of those persons who have had repeated accidents, and an analysis of all the circumstances involved, is more likely to result in basic knowledge". By this means, agent and environmental factors will not be ignored (23, pp.28, 29).

Nevertheless, much has been written on this subject and indeed the Walbeehm (34) review purports to deal exclusively with it. Many of the host factors which we have included in our classification above are discussed by Walbeehm as being contributory to accident-proneness, although his definition of the term mentions only personality structure. He refers (34, p.1) to an "increased susceptibility to accidents" and goes on to say "Every person is susceptible to accidents, but there are a number of people who, because of their personality structure, run a greater risk of being involved in accidents than others".

It should be mentioned here that Walbeehm makes a

distinction/...

distinction among 3 types of accident-proneness:

Relatively constant - constant over a prolonged period;
Variable - only present during a relatively short period; and
Incidental - present only during an extremely short period.

Dunlap (10) in a review of the literature prepared for the Armed Forces Epidemiological Board also calls attention to this phenomenon of variability in accident proneness. He states that the accident history of certain individuals suggests an "accident syndrome or habit" but adds that "the same dynamics will be encountered in normal people under certain circumstances". A Netherlands writer (Muller, 1958) is quoted by Walbeehm (34, p.22) as saying that "we may only speak of a real accident-prone individual if his affinity for accidents is permanent". Muller talks of an apparent and "constantly increasing shift of drivers from the 'safe' to the 'unsafe' group".

All things considered, one would hesitate to state any definite conclusion on this subject. Perhaps, where large commercial fleets are available for investigation, where records are consistent and carefully kept, where every accident or near accident is systematically reported, and where the proper statistical methods are adopted, there may be some hope of identifying the accident-prone professional driver and either excluding or re-habilitating him. Walbeehm considers the most effective statistical method to be "comparison of numbers of accidents in two succeeding driving periods" (34, p.16). There are many difficulties in the way when one envisages the application of these procedures to the general driving public.

It would appear from Walbeehm's review that the phenomenon of accident-proneness does exist, but that it is not, at the present stage, known to what extent the accident-prone driver contributes to the total sum of road accidents.

Finally we quote from Goldstein, who makes the following two concluding statements:

"Accidents/...

"Accident records themselves do not measure a very stable human performance characteristic; accident status in one period is only slightly related to accident status in another." and "Accident repeaters do not account for much of the total of traffic accidents on record". (13, p.5)

II. AGENT FACTORS

Gordon (14) states, with reference to the agent factor and accidents in general, that "a fall may be related to such dissimilar agents as a faulty ladder, a playful puppy, or a misplaced handbag" (15, p.22). Similarly the agent in a road accident may be the failure of some mechanism in the car (defective brakes, blowouts, etc.), faulty design of equipment, or unexpected behaviour on the part of another driver, pedestrian - or even the "playful puppy".

1. Mechanism Failures

Norman (27,p.86) says that "a relatively small proportion of accidents appear to be due to vehicular defects". Nevertheless, as far as these are concerned, one can only stress (as is done both in Norman's review and in that of McFarland) the importance of inspection, maintenance and repairs.

2. Car Design

It is evident from our reading, that, in car design, although some progress has been made in terms of fitting the machine to the man (improved visibility, safety-belts, etc.), much still remains to be done. At the time of the McFarland review, most development in this respect appears to have been in relation to military populations (23, p.69). Mr. A.B. Bourne, speaking at a conference on Safety in Motoring (30) as nominee for the R.A.C., A.A., and R.S.A.C. (U.K.) is reported to have said "the controls of a motor vehicle are much the same in concept as they were at the time when the A.A., R.A.C. and R.S.A.C. were formed". He stressed the difference in present day conditions and requirements, and added that "ergonomists

outside/...

outside the motor industry and without specialised knowledge of motor vehicles .... might suggest fresh approaches".

Suggestions as to areas in which this type of research (anthropomorphic, visual perception, kinesthetic) could be extended, and where the psycho-physiologist might co-operate with the car designer, are made by McFarland (23, Ch. VII). Tolerance limits of the human body to various fatiguing and harmful elements have also been studied, but here again, more research is necessary (23, pp.74, 75).

3. Unexpected Behaviour

As can be imagined, this heading covers a very wide field. It is believed that the type of data at present being collected by the road safety unit at Pretoria should, through time, provide some information on the extent to which this factor plays a part in accident causation. Education of the road user (driver, cyclist and pedestrian) as recommended by most writers, would lessen the possibility of unexpected behaviour. Intensive training of drivers in normal and emergency situations is also recommended (27,p.6). Evaluation of driver training programmes has shown some promising results (23, p.67). The effect of stage-introduced Driver Improvement Action, applied on the basis of a points (demerits) system (as outlined by Lynette Shaw in a recent newspaper article) is reported by Campbell (5).

Where education is concerned, most writers are agreed that this cannot begin at too early an age. This refers particularly to child pedestrians and cyclists.

III. ENVIRONMENTAL FACTORS

1. Atmospheric Conditions and Level of Illumination

The question of visual perception under poor weather conditions or during night driving has received some attention.

Walbeehm (34, p.89) quotes figures given by a German investigator, showing that accident rates increase from 5% to 30% under varying atmospheric conditions.

It can also be inferred from accident statistics that more accidents occur when illumination is poor, due to bad weather or darkness, and that accidents decrease when illumination of highways at night is increased, or tail-lighting is improved (23, p.79). The subject of night vision and adaptation to dazzle has already been mentioned in Section I, 2 (a) (Visual Acuity), with particular reference to the older driver.

Vitamin deficiency during the winter months (especially in certain countries) is also thought to affect light/dark adaptation.

Temperature and humidity are known to cause deterioration in skilled performance in industry (34, p.87), and McFarland (23) says also that there is "increasing evidence of the deleterious effect of carbon monoxide in small concentrations". McFarland and Norman (27) appear to agree that no data are available on this subject in relation to motor car driving.

2. Perceptibility and Legibility of Signs and Markers

Certain design criteria have resulted from studies conducted in this field. It seems to be the general opinion that more remains to be done, in terms of research in the field of visual perception.

3. Road Engineering

According to Norman, it is "present practice" to adopt many devices aimed at highway safety. Such features as zebra crossings (which are claimed to have resulted in 10% reduction in pedestrian deaths), turnpikes, widening of narrow sections, fly-over or underpass bridges, lighting and pedestrian regulations are mentioned. (It is our impression that the Road

Research Safety Unit would appreciate our emphasis on the need for the adoption of such devices, or the extension of their use, in South Africa).

Although Crawford (9) in his review of studies done on fatigue (see p.11 and 12 of this report) mentions the fatigue engendered by a monotonous task, we have so far come across only one writer, Sichel (31), who mentions the hypnotic effect of monotony on long stretches of straight road, and suggests that this is the road engineer's responsibility.

An article by McMonagle (24) who studied the effect of roadside features on traffic accidents, is rather severely criticised by Haddon on the grounds that many associated variables were ignored (15, pp. 217, 224). Haddon also reports, without adverse criticism, a study by the same author on the relation of traffic signals to intersection accidents. The latter study was based on case histories, and Haddon comments (15, p.674) that "This emphasizes once more the necessity of studying the real world in which accidents occur, of avoiding unsupported generalizations and of evaluating the measures that are used".

4. Traffic Density

Statistics from various sources seem to prove fairly conclusively that this factor has an important bearing on the number of road accidents. Norman gives data on hours of day and days of the week when most accidents occur in Great Britain and in the U.S.A. (27, pp. 43-46), with information as to what type of road user is most frequently involved. He also discusses seasonal prevalence and the differences between urban and rural areas. Biesheuvel and Barnes (3) give similar information in relation to motor cycle accidents in South Africa. Michaels (25) reports that there is a direct relationship between driver tension and volume of traffic.

5. Social/...

5. Social and Cultural Environment

Haddon quotes J.E. Gordon as saying "whatever the kind or nature of mass disease or injury, the part exerted by the socio-economic environment is probably the most neglected of any epidemiologic influence ...." (15, p.17). Where road safety is concerned, particularly in South Africa, one feels it is not only the socio-economic environment (although this obviously has its importance), but the social and cultural forces (with their influence on attitudes) that merit attention.

When the field of attitudes is approached, it is clear from the literature that many writers and reviewers consider these to be of vital importance. Goldstein, in his review, says (13, p.6) "It might be argued that, as far as human variables are concerned, accidents are largely a function of age, alcohol and attitudes", and several writers are mentioned by McFarland (23, p.91) as regarding this matter to be "crucial in the highway safety field".

Problems with regard to the measurement of attitudes are numerous. McFarland (23, p.91) refers to certain attempts to construct attitude scales, but considers these to have had only a modicum of success. At the time of writing, pending advances in the methods of identifying and measuring attitudes, he felt the information available to be indirect and speculative.

In 1957, Goldstein and Mosel (12) reported on the development and administration of a 186-item attitude scale considered to cover 14 aspects of drivers' attitudes. A factor analysis was carried out by them on the results of this, and five factors were identified: viz.

(i) Attitude toward competitive speed.
(ii) Attitude toward other users of the roadway.
(iii) Attitude toward "cops".
(iv) Attitude toward the vehicle.
(v) A general attitude of care or concern for safety.

More/...

More recently, Haner (16) reports on attitude inventories drawn up for the Farmers Mutual Reinsurance Company, and claims that these have some predictive value.

One major criticism of the attitude survey is the fact that subjects with a certain degree of sophistication can very quickly see and respond with the socially acceptable answer. Built-in "truth checks" as used in the Haner studies have to a certain extent eliminated this possibility. No details of the content of the inventory are given in Haner's article.

Despite these difficulties, it is felt that there are certain types of attitude survey or opinion survey, which might be carried out with advantage. These investigations, if administered to a comprehensive cross-section of the population, would serve a dual purpose.

(a) in determining what sort of attitudes are held by various sections of the community on a variety of matters relating to driving and road safety in general, and

(b) in bringing the whole matter to the attention of the general public.

The nature of such proposed studies will be further discussed in Section F of this report.

E. METHODS OF DATA COLLECTION

It was felt that this aspect of road accident and safety research merited special attention, for the following reasons:-

(i) Our immediate problem is to decide upon the planning of our own research on road safety, in the C.S.I.R., and in South Africa, and previous methods will therefore be of interest to us.

(ii) It appears that many studies are ill-planned, one variable being studied without holding constant the influence of other factors, or without controls, with the result that whatever conclusions are arrived at must be viewed with considerable reserve.

We do not wish to imply that previous research has been of no value, but we are convinced that it would be wrong for the C.S.I.R. to embark on research until the most careful thought has been given to the whole question of research methods.

From the individual studies we have abstracted, we have formed some idea of the methods adopted by previous researchers, and Haddon (15) reproduces some articles and reports in their entirety, giving his criticism where he feels errors have been committed. He claims to have selected "the best available examples of their types". His opinion of the literature on the subject of accidents in general is that it is "largely parochial, fragmented and divergent" (15, p.14).

The reviews under discussion are rather uninformative concerning research methodology generally, and also to some extent about the methods by which data were collected and the procedures followed in their analysis. In the discussion which follows, we shall devote some attention to all these aspects of research.

I. ASSUMPTIONS REGARDING "HOST" FACTORS

(a) Statistical Approach

In this type of study, an arbitrary decision is made about the types of causative factor to be investigated, e.g. age, sex, driving experience, etc. (19) (20) (32) By means of questionnaires in some cases, and from consultation of the record files of traffic or police departments, an "accident" sample is drawn (often those involved in fatal accidents). The control sample (where the study is "controlled") is usually drawn randomly from the general driving population or represents a group of "accident-free" drivers.

It is then determined whether the experimental sample differs significantly from the control sample on one or more of the variables studied. On the basis of such analyses, the authors may then be able to say, for example, that one sex is more often involved in accidents than the other, or that this is true of a particular age group.

While such studies are of value and interest, they can be criticised on the following grounds:

i. These studies do not allow one to determine the inter-relationship between host, agent and environmental factors, and there is no way of telling to what extent the latter two factors created the situation in which the host factor became causative in the accident.

ii. There is a good deal of reliance on "secondary" sources of information, such as accident reports and entries in files, whose accuracy is doubtful, in many cases.

(b) Laboratory Studies

In these investigations, the experimental and control samples are compared in terms of measurements made of

physical /...

IV. STUDIES WHICH ENDEAVOUR TO COMBINE HOST, AGENT AND ENVIRONMENTAL FACTORS

1. Statistical Approach

In these investigations, an attempt is at least made to assess the relative influence of a variety of factors which might result in an accident (3), for example:-

Age
Time of Day
Weather
Road Conditions
Locality
Attitudes of Drivers

Valuable information is sometimes obtained from such studies concerning the peak periods when accidents occur, weather conditions, road conditions, locality, etc. Their weakness lies in the fact that they rely on reports which may be unreliable, or upon the type of information obtained from questionnaires (rather than that obtained by means of interviews).

2. Observational Approach

Science begins with observation and measurement, but in accident research, this is extremely complicated and difficult, and for this reason very few investigations make use of the observational method, which begins with the accident itself, as an event to be studied.

Since our survey of the relevant literature has convinced us that the observational method is the only ultimately satisfactory one in accident research, we describe the procedure in some detail.

Data /...

Data collection is undertaken by a team of experts, usually consisting of:-

an engineer;
a medical doctor; and
a psychologist or sociologist.

Equipment should include a suitably equipped vehicle, by means of which the team can get to the scene of the accident, as well as apparatus for obtaining photographs, measurements, and other records of the accident.

The events, actions and behaviour leading up to the accident are studied and recorded as carefully as possible by questioning witnesses as well as those involved in the accident in those cases where they remained conscious and the accident was not fatal.

The engineer makes observations regarding the road, traffic generally in the area, and the car (or cars) involved in the accident. Weather conditions also require to be noted by one or other of the observers.

The medical doctor can usually make his own observations on the spot, but as a rule the psychologist or sociologist makes appointments to call on the occupant(s) of the car(s) at their homes or offices, at a time indicated as suitable by them. During this interview, a wide range of information is obtained, not only about the accident itself, but about the background of the person concerned, biographical details, driving history, and also some insight into his attitudes.

An important aspect of this procedure is that it permits a better interpretation of the data than is possible with other methods. The write-up of the accident event gives an indication of the most probable cause(s) of each accident. One is able to take into account host, agent and environmental factors, and subsequent statistical analyses, when large

numbers /...

numbers of accidents have been recorded, will indicate the relative frequency or importance of different classes of causative factors.

One disadvantage of this method is that it takes time, not only to study a single accident, but also to build up a record of accident events, sufficiently large to allow trends or patterns to be observable. Nevertheless, if this is the only way in which the basic and essential data can be obtained, then it would be foolish to delude ourselves into adopting procedures simply because they are quick or cheap, while otherwise relatively useless.

The cost of the observational method is also likely to be very high, although probably not excessive, if seen in relation to the cost of accidents, when the latter is assessed in terms of lives, mutilation, hospitalisation, and vehicle damage.

Another type of observational study is described by Billion (4). Here the data were collected in two phases: by interviewing drivers in their homes, and by observing motorists as they drove in the streets. The observation was done by following drivers for a minimum of 1 mile and a maximum of 2½ miles while they were driving, the observors using scales on which different aspects of a person's driving could be tested. Later those drivers were identified through the Motor Vehicle Bureau in order to obtain their accident records. The drivers interviewed answered questions relating to personal, social, health and driving characteristics. Here again information was obtained regarding accident records. Responsibility for any accidents in which they were involved was taken into account both in the case of observed drivers and interviewed drivers.

By the above method, both accident-responsible and accident-free groups can be compared, but in this case (as in so many studies) the investigators are dependent on records

made /...

made by official bodies, whereas in the previous type of observational study described there is a much greater likelihood of maintaining consistency and accuracy.

V. ATTITUDE STUDIES

Some attempts have been made to construct attitude questionnaires, particularly as regards attitudes towards driving itself (towards other road users, towards "cops", towards speed, etc.). Some of these have already been referred to in Section D, III, (p.19,20 of this report). We have so far been unable to obtain any information as to the content of these questionnaires, the method of administration, or (except in the Haner (16) study) the choice of the sample.

Case and Stewart (6) describe briefly the development of a driving attitude scale, in the Institute of Transportation and Traffic Engineering of the University of California. The scale consisted of 55 multiple choice items based on descriptions of actual traffic situations. From this scale, certain item alternatives which differentiated between two criterion groups of drivers (Fast and Slow) in one sample of university students were incorporated into three sub-tests. Using these three subtests, or response keys, predictions of speed classification as fast or slow were made for an independent cross-validation sample of subjects. Predictions were correct for about 66% of this latter group. Further research, it was hoped, would enable the investigators to describe driving attitudes which seem to be characteristic of other criterion groups.

Since we feel that there are many more attitudes than those directly associated with driving that may be co-active in promoting what Fox (11) in an article on countermeasures in drinking and driving calls the "motivation to avoid accidents", we make some suggestions for further research in this area, in the following section.

F. CONCLUSIONS /...

F. CONCLUSIONS AND RECOMMENDATIONS

In this section, we shall first of all attempt to sum up briefly the conclusions we have found expressed in reviews and individual articles, together with the writers' suggestions regarding preventive measures. Our recommendations for future research and observations regarding preventive measures will follow.

So far as the causes of road accidents are concerned, there is a disappointing lack of definite evidence available. Most of the studies show some conflict of opinion, and the results are in many cases vague or merely suggestive. When the general question of an approach to road safety research is discussed, however, we find more than one reviewer to be in agreement on certain points:

I. GENERAL CONCLUSIONS DRAWN FROM LITERATURE

1. The Multiplicity of Factors Involved

Because of the multiple nature of the variables involved in a road accident, and the interaction of these variables with one another, many investigations are criticised on the grounds that they tend to study one aspect of the situation "in vacuo". Reviewers stress the need to be aware of the total situation.

2. The Need for a Central Concept

Arising out of the above conviction, they point out the desirability of conducting research within a central conceptual framework, and mention the possibilities of the epidemiological approach.

3. Sources from which Accident Data is Obtained

The practice of producing research results based on records extracted from police or traffic department files is deprecated, on the grounds that in many cases these lack uniformity, consistency, completeness and accuracy.

4. The /...

4. The Adoption of an Interdisciplinary Approach

The opinion is frequently expressed that the presence of a variety of interacting variables present in the causation of a road accident calls for the attention of skilled practitioners in many disciplines.

5. The Need for "Control" Groups when making studies of "Accident Repeaters" is pointed out.

II. CAUSATIVE FACTORS

These can be roughly classified under two headings, viz.:

1. Factors, the extent of whose influence on the incidence of traffic accidents does not appear to have been clearly established:

   (i) Psycho-physical predictors (with the exception perhaps of visual acuity) - "results meagre and conflicting" (pp. 7, 8, of this report).
   (ii) Diseases - little known (p. 8).
   (iii) Intelligence - Conflicting evidence (p. 8).
   (iv) Age - with the exception of younger age groups, no definite evidence (pp.8,9).
   (v) Sex - nothing has yet been proved (p. 10).
   (vi) Accident Proneness - does exist, but can be a variable state (pp. 13, 14, and 15).

2. Factors about whose relationship with traffic accidents results are definite or strongly suggestive:

   (i) Personality Factors (pp. 6, 7).
   (ii) Marital Status (p. 9).
   (iii) Temporary or relatively permanent mood states - depression, aggression, antisocial feelings (pp. 10, 11).

(iv) Alcohol /...

(iv) Alcohol - definite relationship established (p. 11).

(v) Drugs and Medicaments (p.11)

(vi) Fatigue (pp. 11, 12).

(vii) Mechanism Failures (p. 15) - an undeniable cause, though apparently responsible for a relatively small proportion of accidents.

(viii) Car design (ergonomics) (pp. 15, 16).

(ix) Unpredictable Behaviour (lack of training and education in safety rules) (p. 16).

(x) All environmental factors (pp. 16, 17, 18).

(xi) Attitudes and their development in the social context (pp. 19, 20).

We do not claim in this categorisation to have covered the whole field of motor accident causation. It is very probable that some points have eluded us. It may even be, as Rapoport (29) says that "....the various statistically determined 'causes' of accidents which we isolate turn out to be only pseudo causes" and that "something more basic is wrong with us" (e.g. as Haddon speculatively suggests (15, p.10), a psychological need for violence in the human being).

Nevertheless, however inclined we may be towards this latter opinion, it is felt that research should primarily be directed towards those factors where there is more possibility of applying immediate remedial action. We again quote Rapoport as saying: "The good physician will investigate possible organic causes of a disease before he delves into psycho-somatics".

III. THE PREVENTION OF ACCIDENTS

From the Norman (27) review, it is possible to extract a fairly comprehensive list of the preventive measures suggested in the literature. He discusses these under four main headings:

administrative /...

administrative measures, the road, the vehicle, the road user.

1. Administrative Measures

He begins by emphasizing the need for multiple preventive measures, the co-operation of experts, and finally a "more co-ordinated system or method of handling road traffic accident prevention as a single problem". He suggests that one authority (e.g. the public health department) should be clearly responsible for the prevention of road accidents. He makes various suggestions (27, p.83) regarding record keeping, whose adequacy is of such importance in the effective assessment of any preventive measures applied.

2. The Road

Where highways are concerned, it is felt that, though further research will undoubtedly reveal better methods of designing and surfacing, "sufficient knowledge already exists to enable those responsible to provide roads with a high degree of safety" (27, p.84), the limit to such activities being the amount of money available for this purpose.

Further suggestions in this area are: separate traffic lanes for cyclists, pavement barriers between traffic and pedestrians, and restriction of vehicular traffic in shopping areas. These are related to built-up areas. On the subject of inter-city traffic, he mentions the need for roads to be of adequate width, with restricted access, dual carriageways and fly-over junctions, no railroad crossings, no stop signs and no traffic lights. He goes on to say: "At the same time, speed should be restricted to moderate and realistic levels, and speed limits strictly enforced". (27, p.85)

3. The Vehicle

With regard to the vehicle, one must consider not only accident prevention but also injury-prevention in the event of an accident. The former aspect concerns car design and the necessity for it to be related to the human being's

physical /...

physical capacities - visibility, location of controls, glare and the use of polarized light in headlights, adequate ventilation, etc. Compulsory testing of vehicles at six monthly intervals, irrespective of the age of the vehicle is also recommended (brakes, lighting, tires and steering being the commonest defects found when tests are undertaken, although exhaust systems should also be checked for dangerous accumulation of fumes). Norman, also (27, p. 86) makes an interesting suggestion regarding the compulsory building in of speed controls. He quotes the Cornell University Medical School (1957) in the following terms "If speeds were controlled to a maximum of 49 m.p.h., 40 per cent of the dangerous and fatal injuries to vehicle occupants in the United States would be prevented".

Many suggestions are made regarding the design of vehicles in such a way as to minimise the extent of injury to drivers, passengers and pedestrians in the event of an accident. Examples of these are the elimination of projections and sharp cutting edges, effective padding, recessed steering wheels, "crash-bars" for two-wheeled vehicles, and (probably the most important, since head injury is reported to be the main cause of death among vehicle occupants) the wearing of safety caps or helmets.

4. The Road User

When one considers the fallible human element, so frequently responsible for traffic accidents, the measures that offer most hope for their prevention appear to be education and controls. According to Norman, the fact that difficulties exist in the application of controls and penalties (insofar as the guilty motorist frequently "gets away with it") suggests that the former measure may well be the more effective.

(a) Education and Training

Education of the road user in road safety measures, starting at the earliest possible age and

continuing /...

continuing through life, so that people may become aware of their limitations - through disease, physical disabilities, temporary emotional or physical upsets, fatigue, alcohol or old age, - is an area urgently demanding attention.

Training of drivers is of the utmost importance, and a high level of competence should be attained before any person is allowed on the road. Reference has already been made (on p.16 of this report) to the success claimed for driver training programmes. McFarland et al (23) mention the need for the development of practice for overlearning and automation in operation to take place, and for practice in operation under adverse circumstances. Norman (27) suggests government controlled or licensed driving schools, the training of instructors, training and education for "defensive driving", training in the dangers and prevention of skids, and in the handling of skidding vehicles. He also recommends the training of learner motor cyclists off the road, and that these particular road users should only be allowed to drive heavier machines after having experience with light ones. He emphasizes the need for complete competence in the child cyclist, and says that in congested urban areas, it may be wiser for the child not to ride a bicycle at all.

As an added incentive to drivers to improve driving skill, a form of advanced driving certificate could be introduced. In Great Britain, "such a certificate is obtainable after examination and test from the Institute of Advanced Motorists" (27, p.93)

The keeping of individual accident records is also advocated. Verdoorn (33) also makes a point of this, and even suggests the fingerprinting of each driver. These accident records would have to be

viewed in relation to mileage driven, but would serve to identify the accident repeater, so that driver-improvement action on a points (demerits) system (8, pp.2 and 19), as used in America, could be applied.

Other suggestions are the periodic medical examination of drivers, and the compulsory examination by a doctor and psychologist or psychiatrist for those found guilty of a serious or criminal offence.

(b) Legislation and Controls

The above heading covers all forms of control introduced by legislation for the protection of the road user. His attitudes towards these controls and his acceptance of them is of primary importance here. Suggestions in this field include such measures as compulsory testing of vehicles (mentioned on p. 32 of this report), compulsory use of safety devices, speed controls, penalties in the form of fines, or suspension or revocation of driving licence, periodic medical examination as indicated above, stricter forms of test for obtaining a driving licence, and finally (and probably most important) controls regarding the consumption of alcohol before driving. Norman says:"If no motor vehicle drivers ever drove when their blood-alcohol level was 50mg/100ml. or more, there would be a reduction in accidents, and legislation to this end might therefore be an effective accident-prevention measure" (27, p.95).

With regard to controls of any kind, Norman makes the point that increasing the probability of being detected in committing minor or major driving offences is much more likely to act as a deterrent than increasing the penalty for the offence. In other words, there is little use in introducing controls if the possibility of enforcing them in rather limited.

IV. RECOMMENDATIONS

1. Future Research

Although some useful information has come to light from past research, Haddon (15, p.14) criticises it on the grounds of being narrow "in its subject matter, concept and methodology" and at times "merely eclectic". We feel, therefore, that many types of research should be rejected, for example the study of accident repeaters with a view to determining their characteristics as predictors of future accidents among the total population.

In view of Haddon's criticism, also, we suggest that the research recommended in sections (ii) and (iii) below, be regarded as supplementary to the case study method.

(i) The Case Study Method

A study of the literature confirms our impression that the case study, or observational method, as practised at the moment by the Road Accident Research Unit of the Road Research Institute (see pp.24-26 of this report) can be highly recommended. As will have been observed from our previous comments, this method is epidemiological in its implications, emphasizing as it does the need, so frequently stressed by reviewers, to see the total picture.

(a) Proposals for Extending and Augmenting the Study of Cases

Attention has already been drawn to the costly and time consuming nature of the above method of research. Obviously, in order to achieve understanding of the interrelationship of the many factors involved in an accident, the number of case studies investigated must be sufficiently large to permit statistical techniques to be applied.

In/...

In order to overcome this difficulty and to speed up the collection of data, we feel that vigorous efforts should be directed at making this method more widely known, and towards obtaining the necessary funds and personnel for the setting up of further case study units at other major centres in the Republic, such as Johannesburg, Cape Town, Durban, Port Elizabeth and Bloemfontein.

Since this is, to a large extent, a question of availability of the necessary funds, it is proposed that an appeal be made for financial support to certain types of organization, to whom the question of road safety can surely not be a matter of indifference, e.g:

Motor Manufacturing Companies,

Oil & Petrol Companies,

Manufacturers of Tarmac for Road Construction,

Manufacturers of Cement (which will probably play an increasingly important role in road construction),

Motor Insurance & Life Insurance Companies.

An added possibility would be to supplement the contribution of those companies by a campaign to attract funds from the general public (as is done for other health projects).

(b) Organization of the Case Study Units

One has the impression that, in order to function at their best, case study units should consist of an engineer, a medical doctor, a sociologist or psychologist, and possibly clerical assistants. These units could be set up as part of one or other of the University Departments.

(c) Responsibility/...

(c) Responsibility for Co-ordination of Research

It is felt that this responsibility should rest with one particular body, to avoid the present confusion and lack of integrated effort. This, in the case of South Africa, could be the C.S.I.R. - more specifically the Institute of Road Research, who could control the activities of the various units, and be responsible for the recruiting and appointing of staff, and for controlling whatever funds are available.

(d) Accident Statistics

We have come to the conclusion that the usual accident records, as kept by police and municipal and provincial traffic departments cannot form a satisfactory basis for statistical studies of road accidents (34, pp. 23-32). Furthermore, we feel that to accept the fact that this cannot be remedied is to adopt a defeatist attitude.

In recommending the case study method, therefore, (with its potential for collecting a number of cases systematically and consistently recorded) we make the additional suggestion that a statistician be appointed to the Accident Research Unit of the Road Research Institute, whose job would be, amongst other:

- to investigate what sources of accident records there are in the country, and to endeavour to introduce a uniform method for the recording of accidents,
- to be concerned with the collating of accident statistics and their publication,
- to ensure that published statistics of accidents are broken down in the most useful form to give details of: racial groups, age groups, centres, types of road user, etc.,
- to advise the C.S.I.R., Accident Research Unit, regarding the type of data which would be most useful in later statistical studies.

(ii) Supplementary/...

(ii) Supplementary Research

Concurrently with the research suggested above, investigations could be made into a number of psychological and psycho-physiological aspects of driving, such as further study of personality factors, perceptual factors, kinesthetic feedback, etc., with particular reference to the 'normal' driver. Other suggestions regarding the research contributions which could be made by the ergonomist and psycho-physiologist are made by McFarland et al (23, pp. 104-107).

An analysis of the task of driving as recommended by Norman (27, p.102) could be undertaken. Herbert (17) has described such an analysis.

(iii) Attitude and Opinion Surveys

As a further supplement to the study of "cases", we recommend the carrying out of opinion and attitude surveys on the lines suggested below. Such surveys can of course produce really meaningful information only if obtained from a representative sample of the population.

We have already (pp.19, 20, 27.) made some comments on the desirability of embarking on such projects, and the purpose they might serve. Some examples of the type of survey we have in mind are given below:-

The attitude held by an individual towards what he considers to be his inalienable rights as a citizen of a democracy are often at conflict with the restrictions which any Government feels called upon to impose. We refer, in this connection, to a recent press report on the proposed introduction in the U.K. of a breath test (spot roadside checks to identify drinking drivers). Here it was said that some M.P.'s considered this to be "contrary to the traditional principles of British justice". We feel that this is an attitude it would be

valuable/...

valuable to investigate. Few people would be reluctant to express their views on this subject, and there should therefore be no temptation on the part of any subject to falsify his responses. Questions could be designed to cover attitudes towards compulsory safety devices (crash helmets, safety belts, etc.) towards the type of alcohol test mentioned above, and towards police controls and regulations of all sorts (speed limits, parking rules, etc.)

Further types of questionnaire could throw some light on the attitudes of the South African public (White and Bantu) towards accidents in general, towards driving (risk-taking, competitive speed, other road users, etc.) and finally towards drinking before driving (and the social motivations behind this).

It would be interesting also to know to what extent the average driver is really aware of the effect of small concentrations of alcohol in the blood, to what extent his attitudes are affected by adverse propaganda (e.g. in advertising), and what are his misconceptions regarding driving principles in general.

The identification of the above attitudes could provide a useful background against which to view the elements involved in individual accidents.

2. Preventive Measures

Many worthwhile suggestions as to the above have been summarised on pages 30 - 34.

We particularly recommend the suggestions made on page 33. regarding the obtaining of a form of advanced driving certificate, and the keeping of individual accident records for all car drivers. The latter method would make available a control group of accident-free drivers for comparison with those involved in accidents.

We would/...

We would also like to identify ourselves with the statement made on page 32, that educative measures will possibly be more likely to prove effective than controls, unless the motorist is convinced that the probability to being detected is high. Mass media such as the press and the radio could make a contribution in this respect - positively by stressing the importance of the right attitudes (when these have been identified) and negatively by restricting the glorification of speed and power so often present in advertising. School teachers and parents (separately and in parent-teacher associations) could help to instill good road "manners", particularly in the very young. A traffic enquiries column in the newspapers might help to clarify certain points regarding traffic rules upon which road users are hazy.

All these measures, together with the attitude surveys proposed, would help to make the public more safety conscious, and perhaps more willing to accept the type of control (such as the alcohol breath-test) which so often raises a storm of protest.

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