INTERMEDIATE MEASURES FOR TRAFFIC SAFETY – AN OVERVIEW

G.B. Grayson
Transport and Road Research Laboratory
Department of Transport
Crowthorne
Berkshire RG11 6AU
England

To say that accidents are the traditional method of measuring traffic safety is to do no more than to state the obvious. To go further and say that accidents are the only possible and legitimate measure of traffic safety would be just as obvious to many people working in the field. However, there are reasons for thinking that this statement may not be as obvious as it seems at first sight. First, there is the example of other systems where safety is involved. In aviation, accidents are (thankfully) rare events, and much effort is devoted to the study of incidents where accidents have been avoided – strangely termed near misses. Similarly, industrial safety studies rely heavily on the investigation of critical events, where circumstances combine unexpectedly to make an accident likely, but where it is averted. Second, there is some debate about what 'safety' means. It seems that safety is one of those concepts that can only be described in terms of the absence of its opposite, as for example the absence of accidents, or freedom from danger. But if one talks of danger or risk, this ought to include the subjective as well as the objective elements. How the subjective elements should be incorporated into the framework of safety evaluation is still a matter of much debate, but it is widely agreed that they cannot be ignored, even though their relation to accidents is often ambiguous.

Accidents, then, are the traditional measure of safety, but not necessarily the only possible measure. To a large extent it depends on one's standpoint, and whether one is a researcher or a practitioner. Traffic safety research is concerned primarily with understanding the system; practitioners are concerned primarily with management and control of system. Control means manipulation in order to obtain results, and in the great majority of cases results are equated with the reduction of accidents. Thus support for the 'accidents only' view is strongest among the practitioners of traffic safety, who far outnumber the researchers.
The literature on traffic safety research shows that there has long been a search for ways of assessing traffic safety through the use of indirect or intermediate measures as an alternative or as a complement to accident data. The aim of this paper is to provide a short background to these ideas, and to introduce some of the issues that will be discussed at more length in later sessions.

Over the years, the list of intermediate measures that have been proposed has become both extensive and varied. Physical layout, geometric characteristics, operational features, flow levels, and numerous aspects of individual and interactive driver behaviour have all been invoked at various times in the past. (One procedure advocated in England many years ago involved the measurement of glass and plastic debris at intersections - and was able to show a good relationship with recorded accidents at those locations). The reasons for the search for intermediate measures have been stated many times in the past, and are almost as varied as the measures themselves; they range from practical considerations such as dissatisfaction with the quantity or quality of accident data, through moral considerations about the need to identify and eliminate hazards before they cause injury or death, to simple scientific curiosity about the nature of inter-relationships within the traffic safety system. The objectives of these searches are equally varied. At one extreme there is the aim of prediction, which is concerned solely with the statistical problems of assessing the accident potential of locations; at the other is the aim of interpretation, where the emphasis is on the formulation and testing of hypotheses about the safety (or unsafety) of the traffic system.

It is possible to discern two approaches that have been adopted in indirect safety measurement: the statistical, and the behavioural. The statistical approach is usually concerned with the physical and operational properties of the system, and aims to establish functional relationships between accidents and a variety of continuous variables. A large number of such variables in the past have been concerned with geometry, reflecting a belief that good design principles can minimise accident rates. Curvature, sight distances, gradient, and lane width are only a few of the many variables that have been studied, either alone or in conjunction with vehicle flow data. The history of the statistical approach has been one of only mixed success, but much has been achieved in recent years with the development of more powerful multivariate techniques, and it is
now possible to provide designers with quite reliable estimates of the expected accident rates for certain types of location.

This procedure of developing accident prediction functions would seem to have much to recommend it; however, it also has its drawbacks. To start with, the functions are derived from sample data, and are limited by the size and representativeness of the samples; bigger ones may yield different functions. Then, the functions describe relations that may change over time, either gradually or in response to some external factor. However, if functions are found to change, it is very difficult to determine whether this reflects a real change in the underlying relationships, or if it is merely the result of using different or better data. Finally, statistical functions, however sophisticated, only describe relationships, and do nothing to explain them. In summary, this approach has proved to be very helpful to designers, but is of less value to practitioners than might appear at first sight, since being able to predict accidents is far removed from being able to prevent them. For researchers the same argument applies, except that here the aim is to understand accident causation. In short, accident prediction is only a means to an end, and that end is accident reduction. There are many who believe that adopting the behavioural approach may be the best way of achieving that end.

The behavioural approach to the indirect measurement of safety has many similarities with safety activities in other areas, such as aviation and industry, as was pointed out earlier. Though not as old as the statistical approach, it too has a long history, and the list of variables studied has become extensive over the years. It includes traffic violations, headways, driver errors, gap acceptance, hazardous manoeuvres, and near accidents—conflicts. These items all have in common that they are discrete events, and that they are regarded as being in some way a deviation from 'safe' behaviour, in that their occurrence is likely to increase the probability of an accident. With some items, for example traffic violations, the relationship with accidents may not always be clear. However, the claims for the strongest candidates on the list are based on the assumption that there exists a continuum of events, ranging from normal 'safe' driving practice through events that become increasingly critical, and culminating in accident and injury. The study of behavioural measures of the behavioural type can be seen as being synonymous with the study of critical traffic events, one of which is the traffic conflict.
The existence of such a continuum seems inherently plausible, but it should be noted that it conveys two important implications. The first is that the nearer an event is to the accident end of the continuum, the easier it is to demonstrate that it has a high probability of leading to an accident; in other words, it has validity. The second is that the nearer an event is to the 'normal' end of the continuum, the more frequently it will occur, and the easier it will be to show that estimates of its occurrence are reliable. These two issues of validity and reliability are fundamental to any discussion of intermediate measures in safety, as can readily be seen from the literature on traffic conflicts. They also mean that the choice of an intermediate measure is always to some extent a compromise between collecting the 'best' data and collecting enough data. In a similar way, it could be argued that there can be no such thing as the 'best' intermediate measure in absolute terms, only the best for a particular purpose.

As far as application is concerned, the study of critical traffic events can be either prospective or retrospective. It may be employed to estimate the expected accident rate at a particular location, either to assess its hazardousness, or to assess the effects of some form of alteration to that location. Alternatively, it may be used to diagnose safety problems by being able to draw on a data source that is much richer than that provided by accidents alone. Both approaches depend on having first demonstrated the validity of the measure being used. Without validity, prediction is impossible, and diagnosis is pointless. How to set about establishing validity and what criteria should be employed are still the subject of much debate in this field. However, wider acceptance of intermediate measures will almost certainly depend on producing convincing evidence of validity — however that is defined.

Although using behavioural measures as surrogates for accidents may have attractions for practitioners, and is an essential step in establishing validity, it nevertheless only begins to realise the full potential of the technique. For practitioners and researchers alike, the real value of intermediate measures will be found in solving problems, rather than in measuring effects.

While it would be inappropriate for an introductory paper to offer conclusions (since that is the purpose of the sessions to follow), it may be helpful to review the main points that have been raised. First was the question of how to measure safety,
and why this is necessary. Then it was suggested that willingness to consider indirect as well as direct measures often depended on the objectives adopted. Two main approaches to indirect or intermediate measures have been identified, the statistical and the behavioural. The statistical approach is capable of producing powerful results, but it was argued that the behavioural approach can make a better contribution to accident reduction. The assumed continuum of behavioural events was discussed, which led to the fundamental issues of reliability and validity. Critical events in the traffic system can be studied either as surrogates for accidents, or as sources of information for diagnosis. Both activities require that the events studied can be shown to have a valid relation to accidents.

Finally, although the emphasis in this paper has been on indirect measures, it must be stressed that the direct and indirect approach to safety measurement should not be seen as opposing alternatives, but as complementary. Both are needed in order to tackle effectively the problems of traffic safety.