Proc. Instn Civ. Engrs, Part 1, 1979, **66**, May, 323–325

8124 DISCUSSION

Assessment of hazards associated with highway engineering

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Mr A. N. Brant, Director, Midland Road Construction Unit, Department of Transport

One of the aspects of the media reporting on a disaster such as that at the Spanish caravan camp, or Flixborough, is that a false idea may be given of how the hazards should be overcome. I feel that as engineers who are supposed to be trying to cope with these hazards we ought to guide the public a little more and dispute with the media when they make references and statements which are misleading.

44. With some of the hazards that one should take account of, the risks may be unmentionable, as the Author says, for security reasons. However, this should not preclude us from including them in our assessment and in our justification for the measures which we propose. I consider that the ring roads around major conurbations, such as the M25 and the M42, should be justified in the eyes of the public not only on the basis of the traffic which will use them and the accidents which will be prevented generally, but on the basis of what will be the situation in the event of some major civil calamity taking place in the conurbation—an event such as that at Flixborough—when access is needed for a considerable number of emergency services and there is a requirement for exit perhaps in a very rapid way. Yet we do not really take things of this sort into account, and do not publicly say so even if we do.

45. The recent policy White Paper on roads points out that designs are taking 10–15 years to come to fruition and says that the decisions which are taken in that period of 10–15 years should include considerations of risk; we should not wait until the end of that period before we decide what the risks are likely to be 15 years later. We ought to be thinking of the hazards of the future and building the solutions into our designs, perhaps in the cost/benefit way that the Author has described.

Mr J. L. Hammond, Department of Transport

I congratulate the Author on presenting a theory which can be developed over the years. I think, however, that its development in relation to roads is much before its time.

Mr R. J. Bridle, Chief Highway Engineer, Department of Transport

It is essential to identify all the risks involved and list them. There is no analytical substitute for that. Secondly, imagination is again necessary to describe the outcome of decisions taken. Analysis can only begin once all the possible decisions have been generated and their consequences set down. Comprehensiveness is very important at this stage and time taken in 'brainstorming' among colleagues is well worth expending if none of the feasible decisions and possible outcomes is to be overlooked.

Paper published: *Proc. Instn Civ. Engrs*, Part 1, 1978, **64**, Aug., 381–391.

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48. It is very easy to treat this activity cavalierly and assume that experience of the past is necessarily a reliable guide. Ritual needs to be avoided as many events fall into the predictable but unthinkable category. In retrospect a gas explosion in a tower block or a lorry hitting a foot-bridge light enough to be dislodged, are clear cut cases which were predictable but not accounted in the risks considered. Vehicles impacting on any part of a bridge or any other structure close to road or rail are similar events where it is necessary to account for the effect of the energy which must be absorbed.

49. The Author has greatly aided professional thinking in writing his important paper and illustrates many shortcomings, both in these processes and in the way decisions are taken after identification of possible events.

50. I would underline the point he makes that often unpredictability in calculated probabilities tends to leave the event ignored. It is important for engineers to accept the definitions that risk is used where the probabilities are calculable and uncertainty where they are not. However, the fact that a likelihood defies computation of risk does not mean that the decision-maker can ignore it or not make the best guess he can.

51. Once the list of events has been determined it will be evident that the economic consequences vary and the problem of distributing both manpower and financial resources is posed in a stark fashion. Where uncertainty is present the decision-maker is forced to take a view of the risks he necessarily must assign in determining the investment to be made. The formulation Mr Acton describes means that the engineer will be required to take an explicit view. In current circumstances, where decisions are made by the 'seat of the pants', the risks are assigned implicitly and the full consequences of that assignment will not be as apparent as in the formulation proposed by Mr Acton.

52. Some examples are apparent and can be quoted. The containment standards for bridge parapets in relation to site hazards—evidently a bridge crossing a stream or a heavily used motorway or railway line requires separate consideration. Some consequences can be horrific and it is sensible for the decision-maker to weigh his decisions accordingly. 'Bridge bashing' by high vehicles is clearly a similar circumstance where consequences and risks involve many variables and statisticians are unable to be precise. That does not prevent rational behaviour in making investments taking due account of the necessary safety assurances.

53. Mr Acton is to be congratulated on his paper which presents methods which, while known in other fields, have hardly made an impact in general civil engineering, even though its history has required it to cope continually with uncertainty and risk.

Mr Acton

First it would be advisable to correct a small error which crept into the text and altered the meaning of one sentence. In § 13, line 4, 'as' should be deleted.

55. **Mr Brant** comments on the need for balanced reporting of hazards by the media. In the autumn of 1978 there was a considerable volume of publicity aimed at transferring dangerous freight from road to rail and the BBC television programme 'Tonight' on 19 September made this point in connection with transport to and from the new Flixborough plant. The other side of the coin is often ignored, the devastating explosion of an ammunition train in the USA a few years ago being forgotten.

56. Most journeys involve travel on lengths of road or rail with different characteristics and through different types of area. The calculation of accident probabilities and costs is a daunting prospect but one which could be faced. The decision tree is a way of comparing alternative solutions to a problem of transporting hazardous materials and, once the tree has been produced, the probabilities can be varied to test the sensitivity of the conclusions. If the best route involves a politically unacceptable risk it can be rejected and the consequences of choosing another route will be apparent.

57. **Mr Hammond** considers that the development of decision tree theory in relation to highways is before its time. Certainly it would be unwise and unnecessary to apply

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it to every problem, but it is a technique well worth bearing in mind when taking or advising on decisions involving risk and uncertainty.

58. **Mr Bridle** makes the cardinal point that analysis can be properly carried out only if all the available information is collected and fully considered. It is vital to have no preconceived idea about the boundaries of the problem. After examination of the probabilities and their associated uncertainties it may well be found that certain factors do not affect the final decision, but intuitive rejection of possible influences must be avoided.

59. Highway engineering, like its parent civil engineering, has innumerable hazards which can all be expressed in terms of risk and uncertainty. Recognition of hazards is the first step in understanding them and this should lead to dealing with them efficiently. The Paper has perhaps made a small contribution to the wider debate and without doubt the subject requires much more study and constant review.

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