A simulation model to predict conflicts at a non-urban T-junction has been developed at Royal Holloway College\(^1\) (RHC). A general description of this model, and some preliminary results relating conflicts to flow and speed are presented in §II. If the model is to be used to assess accident risk at junctions\(^2\), we must be able to relate the conflicts predicted by the model with the injury accident record at such junctions. Empirical data from an appreciable number of junctions must be collected to provide details of the parameters needed as input to the model. An investigation of the relationship between model conflicts and accidents may then be conducted (and hence the model can be calibrated). The methods of collecting the empirical data and the selection of suitable sites for observation are outlined in §III. Details of associated work at RHC are given in §IV, and our current research program is discussed in §V.

II. The conflict simulation model

Six distinct vehicle movements are permitted at the T-junction (Figure 1), which is assumed controlled by a Give Way sign. The right-of-way rules lead to the formation of queues in the centre of the major road and in the minor road, as vehicles wait for an opportunity to turn. The model assumes an infinite line of sight at the junction, and no overtaking is permitted.

Major road streams of traffic are characterised by a flow
rate, a distribution of preferred speeds (i.e. the speed at which a vehicle would travel if it was a platoon leader), and a distribution of inter-vehicle time headways. Drivers of turning vehicles assess the gap available in major road traffic, and make their decision of whether or not to turn according to a gap acceptance function derived from empirical data. If a turning driver makes a poor gap acceptance decision and accepts a gap which is shorter than the time required to complete the manoeuvre, vehicles in the major road are forced to slow down, and a conflict occurs. The severity of the conflict is measured by the deceleration needed to avoid a collision (lane-changing is not permitted in the model). A detailed description of the model is given elsewhere\textsuperscript{1,3}.

Preliminary results

In the model, conflicts may occur at four positions within the junction (Figure 2). The results quoted here are for conflicts of all grades of severity combined, averaged over a series of trials.

Conflicts and flow

Conflict frequency in any position is proportional to the product of the flows in the interacting traffic streams, e.g. for a fixed turning flow, conflict rate increases approximately linearly with major road flow.
Conflicts and speed

Empirical studies have shown that gap acceptance varies according to the speed of the approaching major road vehicles. In the case of the crossing manoeuvre, the proportion of major road vehicles involved in conflict increases approximately linearly with speed; as approach speed increases the median accepted time gap decreases while the crossing time remains constant, so conflict involvement increases. For merging conflict involvement increases faster than linearly; with increasing approach speed, the median accepted time gap decreases, but the time required to complete the merge and accelerate to the speed of the major road vehicle increases. In addition, the merging driver is likely to prefer to travel more slowly than the major road vehicles with speeds above the mean traffic speed, increasing the chances of a conflict with such vehicles.

III. Observations of T-junctions

Site selection

A T-junction must satisfy several criteria to be suitable for our purposes. It should be situated in a non-urban area, since the model simulates a non-urban environment. The junction should have a high injury accident record in recent years, to provide a reasonable number of such accidents to correlate with model conflicts. In addition, fairly high flows are necessary, so that sufficient data to derive the distributions needed for
input to the model may be collected in a few days. Finally, it must lie within an acceptable distance from RHC to enable daily travel to the site.

Thirteen T-junctions which satisfy the above conditions have been identified. Observations were made at eight of these junctions during last summer, in good weather conditions. Observations at the remaining sites began this month.

Methods of observation

Data was collected using the microprocessor based system developed at RHC. The system receives input from either handsets or automatic sensors. Each handset has eight push-button inputs; when a button is pressed, the handset number, the button number and the time at which the button was pressed are recorded. This data is stored on an audio cassette tape.

In general, each observer uses one handset, and observes one stream of traffic at the junction. He presses a particular button on the handset to denote that a specific event has occurred; for example, the arrival of a vehicle, or the start of a turn. Additional information such as the type of vehicle or the sex of its driver may also be recorded. Automatic sensors are used to detect arrivals in one major road stream of traffic, and to collect data from which speeds of major road vehicles approaching the junction may be calculated.

Data analysis

Data from the cassette tape is transferred to a mainframe
computer via a direct link from RHC. The data is then processed to produce the following results: average flow values; speed distributions of major road vehicles; details of traffic composition and driver population; distribution of exposure times for vehicles turning right into the minor road (the exposure time is the interval between the start of the turn and the completion of the manoeuvre, when the entire vehicle has crossed into the minor road) and tables of accepted and rejected gaps for each turning stream of traffic (from which a gap acceptance function is derived).

So far, results from two particular sites have been used as input to the simulation model. The two junctions are close together, and the majority of traffic passing through one also passes through the other, as the major road is common to both. However, the injury accident records for the two sites are rather different.

IV. Associated research

Double gap acceptance

An important part of our simulation work is the modelling of the driver's decision-making process on whether or not to accept a presented gap in the major road traffic stream. A considerable amount of work has been reported in the literature on gap acceptance where the turning driver is merging with or crossing a single stream of traffic. There appears to be little published work on "double gap acceptance" where a driver has two streams of traffic to consider. Work is in progress to examine the gap acceptance characteristics of the minor road
driver wishing to turn right (U.K.) at a T-junction. Preliminary results are now available.\(^6\)

**Sex and age**

Using a slightly different model of driver behaviour, based on the concept of a minimum acceptable gap, the simulation model has been used with empirical data to show how risk-taking behaviour varies with the sex and age of the turning driver\(^7\). It was found that older drivers are more likely to cause conflicts than younger drivers, and males are more likely to cause conflicts than females.

**Daylight and dark**

Very little has appeared in the literature on differences in gap acceptance behaviour in daylight and darkness\(^8\). A pilot study to examine the gap acceptance behaviour of merging drivers at one particular T-junction (the entrance to the College) in conditions of daylight and darkness is in progress. Observations have been made on seven dark winter evenings, using similar techniques to those outlined in §III. The use of headlights or sidelights by oncoming major road vehicles was also recorded. Observations in daylight conditions are now being made. The results of this work will be used as input to the simulation model, so that the conflicts predicted for daylight and dark conditions may be compared.
V. Current research programme

Work is continuing on analysis of the observations taken at thirteen non-urban T-junctions. In the first stage, the basic parameters needed to run the model are derived (see §III) and model conflicts compared with accident records for each site. Cluster analysis and other methods will be used to group the sites, and to attempt to identify those parameters most closely related to conflicts.

Data has also been obtained on sex of driver, presence of passengers, type of vehicle and speeds of approaching major road vehicles. At the second stage of the analysis we will examine the effects of each of these parameters in terms of model conflicts.

We intend to extend the model to non-urban priority controlled four way intersections, and to carry out observations at a number of such junctions. The extended model will then be used to predict conflict rates in these circumstances.

Following the pilot study on gap acceptance in the dark, further observations will be carried out during winter evening rush hours at a subset of the original thirteen T-junctions, to extend our knowledge of the difference (if any) in conflict rates in daylight and darkness.

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VII References


Figure 1