DRIVER INFORMATION ON JOURNEY TIME VARIABILITY GENERATED USING ANPR DATA

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INTRODUCTION

The Highways Agency collected vehicle registration plate data from motorways near Birmingham between June 2000 and June 2001 using ANPR (Automatic Number-Plate Recognition) systems installed on the M6, M5 and at the M40/M42 junction. Journey times have been calculated by matching registration plates and this has provided a valuable source of data for various research purposes related to journey time variability. One use has been a study by TRL into the repeatability of journey times.

The objectives of the study were:

1. To investigate the repeatability of journey times by time of day, day of week and season and therefore the practicality of making such information available to the public;
2. To develop methods to enable the promulgation of the journey time data by way of the internet and other appropriate media.

Journey times may be variable for a number of reasons. One of the major causes is unpredictable incidents, including road traffic accidents; another is predictable events such as roadworks. Unpredictable weather and low ambient lighting also affect the capacity of the road and affect journey time reliability. The remaining source of unreliability is the congestion due to high traffic volumes or 'sheer weight of traffic'. The journey time experienced throughout a particular day on some stretches of road is very variable, in that it varies from the 'normal' journey time (for vehicles travelling at their desired speed) to a maximum value at the peak of the congestion. This type of variability is not necessarily of most concern to drivers. It is the variability from day to day at a particular time that is of most concern. The measure decided upon to quantify this variability is the upper 90th percentile of the mean journey time at a particular time of day: indicating the mean journey time that will not be exceeded on 9 days out of 10. A reliable journey might be defined as one for which this percentile corresponds to an acceptable minimum speed of perhaps 50 mph.

The variability of journey times due to incidents is often greater than the variability associated with high traffic volumes in peak periods. If the chance of an individual journey being affected by an incident is very small then the information provided to drivers on the times of day and day of the week to travel for the journey time to be reliable can safely exclude the effect of incidents. However, if there are many incidents affecting journey times then any driver information may have to take account of the journey time variability they cause. At the outset of the study it was thought that the former situation would predominate and that any information published should exclude incidents. However a preliminary analysis of the first six months of data showed that events and incidents affected a significant proportion of journeys at certain times of day (up to 25%). Hence, it was decided that any driver information published should not exclude incidents. The analysis presented in this report is based on all journey times and includes journeys affected by incidents.

DATA ANALYSIS

The journey times and their variability were studied for six journeys for the period between June 2000 and June 2001. The journeys were as follows and are shown in Figure 1.

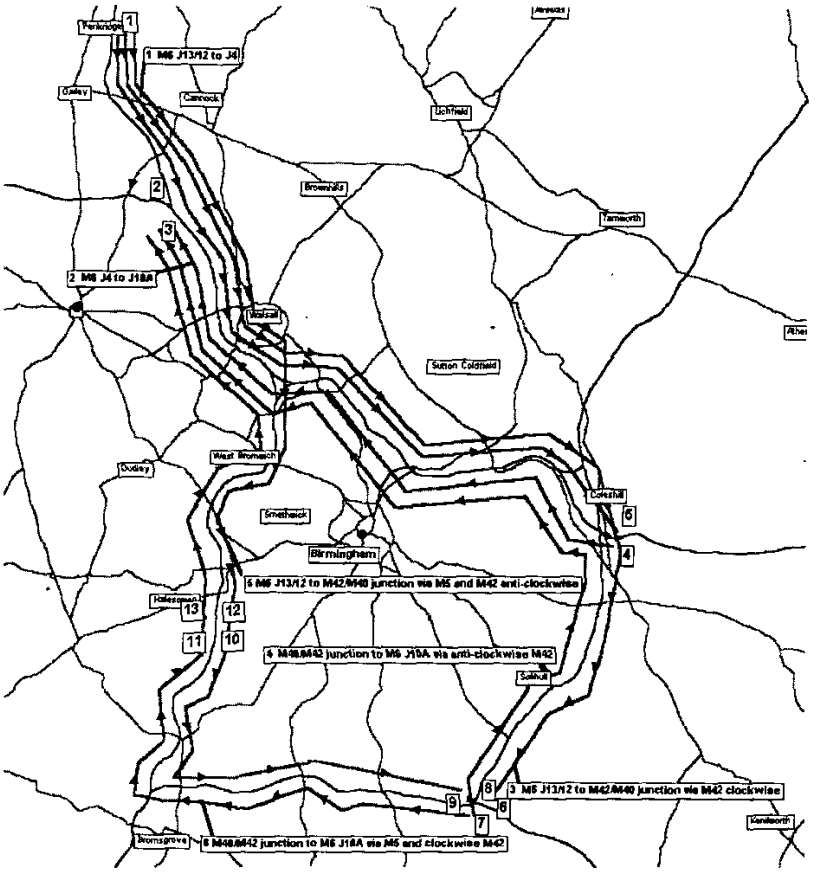
1. M6 J13/12 to J4;
2. M6 J4 to J10A ;
3. M6 J13/12 to M42/M40 junction via M42 clockwise;
4. M40/M42 junction to M6 J10A via anti-clockwise M42
5. M6 J13/12 to M42/M40 junction via M5 and M42 anti-clockwise;
6. M40/M42 junction to M6 J10A via M5 and clockwise M42;

The journey time data used was a record of journeys at all times of day and all days of the week for vehicles that passed the origin and destination. To prepare the journey time data for analysis, certain records had to be removed: exceptional days; outliers; and data for which the system clock was inaccurate.

The preliminary analysis of the first six months' data showed that there were certain day types that exhibited similar journey time characteristics, in that both the mean journey time and the between days variability of the mean at a particular time of day were similar. On this basis it was therefore decided to divide days into 16 categories. These are:

1. Public bank holidays (excluding Christmas Day);
2. The Friday before a Monday public bank holiday;
3. 4. 5. Mondays in school term times in autumn, spring and summer respectively;
6. 7. 8. Tuesday, Wednesday and Thursdays in autumn, spring and summer respectively;

Figure 1 Map of Birmingham showing sites and journeys



9. 10. 11. Fridays in school term time in autumn, spring and summer respectively;
12. Mondays in school holidays;
13. Tuesday, Wednesday and Thursdays in school holidays;
14. Fridays in school holidays;
15. All Saturday;
16. All Sundays.

MEAN JOURNEY TIMES AND VARIABILITY

The mean journey times for 15 minute periods for each day and the variability of the mean between days for each of the 16 day categories were calculated. The graphs in Figure 2 shows the mean journey times for the M6 journey 1.

Figure 2 shows that for the southbound M6 the morning journey times were greatest on Mondays and least on Fridays. Levels were similar in the autumn and spring during school term time and lower in the summer. Journey times in the morning were least during school holidays. Evening journey times were least on Mondays in the summer school term time. For the northbound M6 the morning journey times were again greatest on Mondays and least on Fridays. The relative levels were not as clear as for the southbound M6, although levels were generally lower in the summer school term time and least in school holidays. The higher inter-peak and evening journey times started later than for the southbound M6 and were greatest on Fridays; being similar in the autumn and summer terms and in school holidays and least in the spring term.

Comparisons between the mean journey time and between days standard deviation of journey time for school term time weekdays for the northbound journeys 4 and 6 from the M40/M42 junction to the M6 J10A are shown in Figure 3.

Figure 3 shows that at peak times, the M5 route was generally quicker. In the morning peak, northbound journey times clockwise via the M5 route were lower and variability levels were similar to the M6 route. After 09:30, journey times were lower for the M6 route. On Mondays this state continued throughout the day but on mid-week days from 15:00 to 18:30, journey times via the M5 route were again lower. On Fridays journey times via the M5 route were lower

from 13:00 to 19:00. Journey time variability on mid-week days and Fridays was also lower for journeys via the M5 route in the evening peak period.

Figure 2 M6 J13/12 to J4 Weekdays

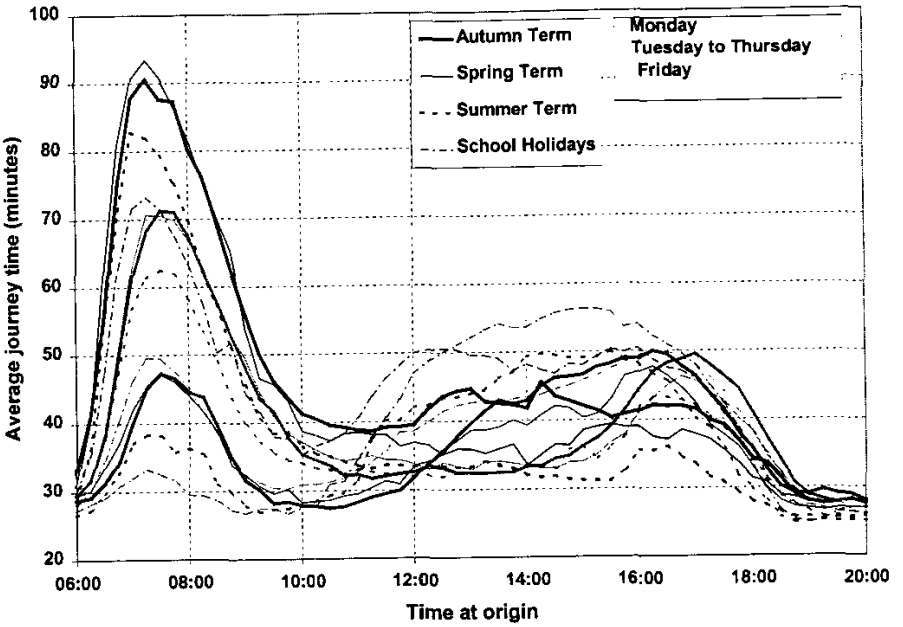
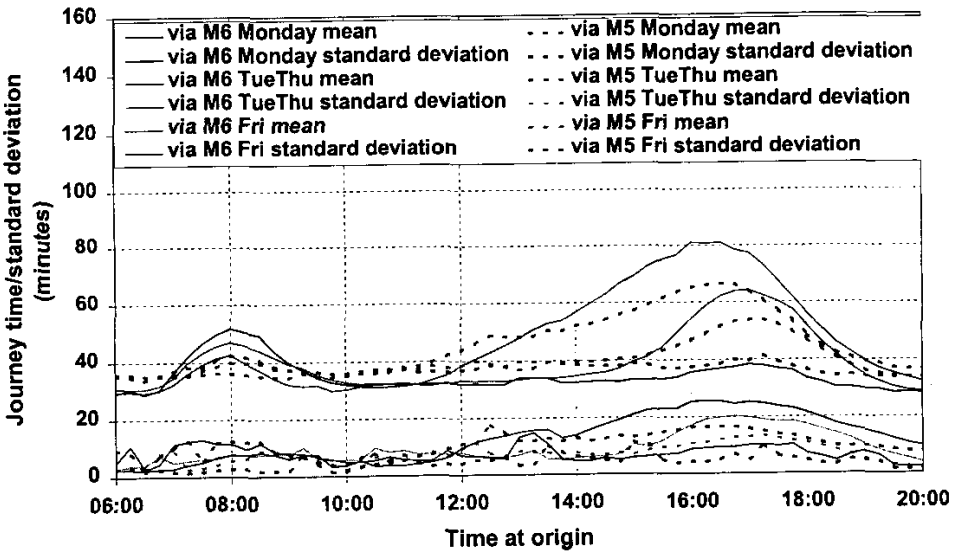


Figure 3 Northbound journey from M40/M42 to M6 J10A in school term time



JOURNEY TIME RELIABILITY

The 90th percentile journey times and the corresponding average speed were calculated for each of the six journeys for each 15 minute period on each of the 16 day types identified. To enable comparisons between journeys of different length to be made, the 90th percentile speeds were assigned to speed bands. To display the broad results the following three bands were used:

< 30mph	
30mph – 50mph	
>50mph	

A journey might be described as reliable if the 90th percentile speed was in the third range, indicating that

on 9 out of 10 journeys the average speed would be expected to be greater than 50 mph. The strip plots in Figures 4 and 5 show the ranges to which the 90th percentile speeds were allocated and show the times of day to travel for the most reliable journey time. Journeys for which the 90th percentile speed was in the red area were both longer and more variable than journeys in the gold or green area, with 1 in 10 journeys being made at an average speed of at most 30 mph. The journeys in the green area were the shortest and the least variable.

Figure 4 90th percentile speeds and journey times on the southbound M6 from J13/12 to J4

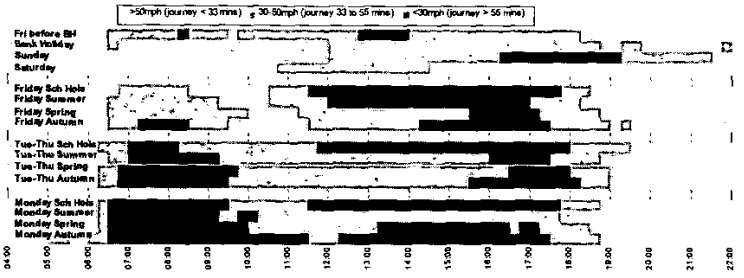
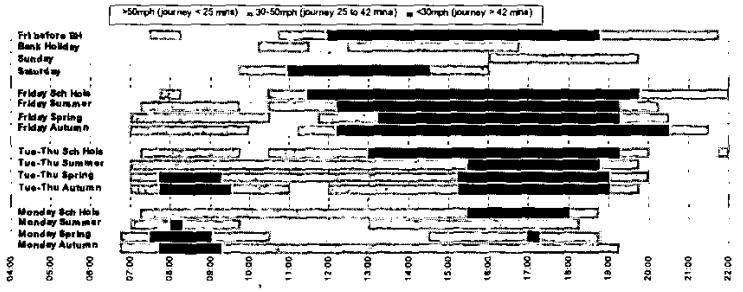


Figure 5 90th percentile and journey times on the northbound M6 from J4 to J10A



INTERPRETATION OF THE RESULTS

The results presented show that there is a seasonal pattern to the journey times on the motorways around Birmingham. The journey times in the morning peak period in the autumn and winter school term times are higher than journey times in summer school term times. The analysis shows that the results for the autumn and spring terms are very similar and that the Friday before bank holidays is not significantly different from other Fridays. It will be necessary to identify summer term times separately but autumn and spring term times can be combined, making a total of twelve day types if the Fridays before bank holidays are not separately identified. The identification of up to twelve day types with consistent journey time patterns through the day has important implications for the promulgation of information to the public. The danger is that leaflets will be too complex, unless only limited information is provided, perhaps for term time weekdays. The same problem may not arise with information on an internet site, as the user will be able to request only the information required.

PRESENTATION OF JOURNEY TIME INFORMATION

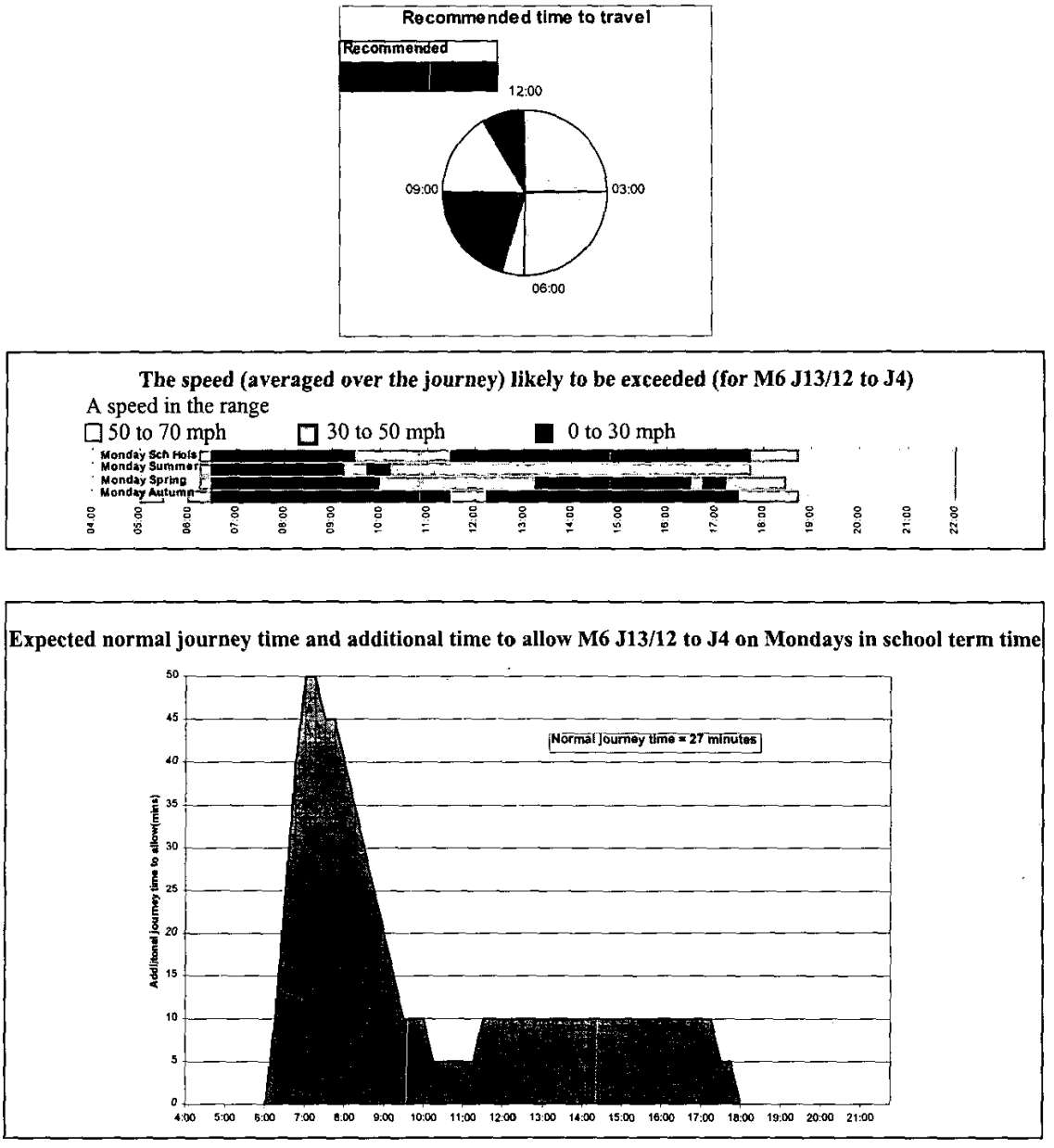
There are a number of possible media for promulgating journey time information to the general public. A simple method would be to produce leaflets for areas of known congestion, such as the western M25, western M60 or Birmingham Box. Alternatively, detailed information on the national network of motorways could be accessed via the internet when more comprehensive journey time data becomes available. This latter method has the advantage that both summary and more detailed information can be stored because the user can access information at several levels of detail.

There is a need for the information to be simply presented and easily understood. The information could take a number of forms. The following are a list of possible types:

- Recommended time of day to travel
- Expected speed and corresponding journey time
- 'Normal' journey time and amount of time to allow

Alternative presentation methods include pie charts, strip plots or graphs. Figure 6 shows the same data displayed using each method. The information is for the journey from the M6 J13/12 to J4 on Monday mornings. The recommended time of day to travel is shown as a pie chart. The expected speed and corresponding journey time are shown as a strip plot and the 'normal' journey time and amount of 'time to allow' are shown as a graph.

Figure 6 Alternative leaflet formats



How an individual driver might use the information is illustrated with the use of an example. A driver plans a trip down the M6 on a Monday in autumn. He knows that there is congestion and wishes to travel early to avoid it. The 'recommended time to travel' pie chart would suggest that he reaches junction 13 before 06:30 but does not give any more information, while the strip plot would suggest that his journey to junction 4 would be made at a speed in excess of 50 mph and take at most 33 minutes if he passed junction 13 before 06:00. The consequences of a later journey are apparent and the driver can make a decision to delay his journey until late morning.

Displaying journey time data on an internet site introduces the possibility of an interactive display, with alternative presentations available. One possible scenario is for the top-level display to show a map of the motorways and ask the user to select the information required from highlighted journeys on the map. The chosen journey would then be displayed in detail; the normal journey time given, for example 20 to 25 minutes (perhaps the journey time at 80 and

112kph) and a number of options offered. These could ask the user to select the date of the journey. The response could inform the user that the date is a particular weekday in a particular month, for example a Monday in February outside the school holidays. Information on this day type could then be displayed in the form of a bar chart, strip plot or graph indicating the recommended time of day to travel. The user could select a particular departure time and the map would display the speed at the chosen time (the 90th percentile) and recommended time to travel. An example of this form of display is given in Figure 7.

An alternative internet application could involve the embedding of the raw 15 minute journey time data within conventional route planning software. The user would specify start and finish points and planned date and time of departure or arrival (similar to the present Railtrack site for train information). The route timing returned would include the 90th percentile time for those sections of the selected route for which measured journey time data was held. The effect of an earlier or later departure time could be readily assessed and even an optimum departure time displayed to minimise travel time.

FUTURE DEVELOPMENTS

The study suggests that there is sufficient predictability of journey times on congested sections of motorway to consider further the promulgation of the information to the public. However the Highways Agency has taken no decision yet on how the information might be made available to the public. The data was collected specifically for research purposes and there is at present no systematic collection of such data on the Agency's network. The inductive loops installed as part of the Agency's MIDAS system allow the simulation of journey times and these are likely to prove a productive source of suitable data in the future. Some 450 km of motorway has MIDAS installed at present and it is planned to expand to cover the most heavily trafficked 30% of the motorway network by 2005.

In parallel with the growth in the availability of the data the Agency will consider if and how it might develop the presentational ideas described in this paper. This may include surveys of the public to assess demand for the service and the use of focus groups to test ideas. The provision of the raw data to third parties for incorporation into their proprietary route planning software is also likely to be explored.

Figure 7 Example of possible internet display