THE BENEFITS OF TRAFFIC FORECAST AND TRAVEL TIME ESTIMATION FOR DRIVERS AND NETWORK OPERATORS.

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ABSTRACT

Different tools are now available that allow traffic forecast and expected travel times to be provided on complex road networks. These tools allow on the one hand, the network operators to implement traffic control strategies better suited to cope with the rapidly evolving traffic situations, and on the other hand provide drivers with accurate travel time information.

This paper presents some of these tools in operation and particularly focuses on the drivers' behavioural changes that have been observed, for the benefits of both the travellers and the operators.

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KEY WORDS

TRAFFIC FORECAST / TRAVEL TIME / INFORMATION / NETWORK OPERATION.

1. PREAMBLE

"Unlike the physical capacities of beams to carry loads or pipes to accommodate fluids, highway capacity involves human beings who are sensitive to the quality of the service they are receiving and capable of reacting to it"

from the foreword to the 1985 Highway Capacity Manual

Travel demand patterns can be classified according to various cycles: daily activities (commuter traffic, goods deliveries, etc), weekly activities (shopping, leisure, etc), holidays, and so on. In addition, exceptional events can create exceptional demand.

Road traffic is then the result of the confrontation between this demand and transport supply, depending on individual choices in terms of modes, time of departure, itinerary. On top of that, as stated above in the HCM, traffic is not a simple fluid flow but involves individual driving behaviour and interaction between these behaviours and learning process.

Traffic forecasting is therefore a complex science that has mobilised numerous scientists, students and PhD's for half a century.

Methodologies and subsequent tools have been developed that we can classify roughly in two main categories:

- methods based on historical data: assuming that travel demand copes with different life-cycles, is then possible to foresee the level of traffic on a certain day, a certain hour in comparison with a comparable period in the past;

- methods based on traffic flow simulation: the assumption is that traffic flow follows laws comparable to fluid mechanics laws (macro-simulation) or more sophisticated laws taking into account individual behaviour (micro-simulation).

Of course combination of these methodologies have been introduced in order to obtain the advantage of both: e.g. instead of using only real time data for traffic simulation models, forecast data based on historical analysis can be used.

Some examples of methodology, derived from known mathematical methods are linear trend, linear regression, Kalman Filter, Neural networks, Bayesian Combined Predictor, etc.

Progress has certainly been made, in particular due to the improvement of data collection systems. A high density of measurement points and longer series of historic data have allowed traffic analysis and predictive laws to be improved: “The more measurement values that exist, the more accurate the forecast will be” as stated in most instruction manuals for traffic simulation tools. However, for the operators or the drivers, results are still unsatisfactory: there is still a lot of uncertainty in traffic forecast, whatever the method is.

Two reasons can be identified:

- changing in mobility behaviour: this is particularly important in developed countries where leisure time is more and more used for mobility;
- traffic forecasts are used for informing drivers and modifying their behaviour in order to alleviate congestion.

As a consequence of these modifications, it is then difficult to assess the accuracy of traffic forecast tools: the usage of historic data becomes questionable while the reality is also modified thanks to traffic control measures and traveller information services.

2. NETWORK OPERATORS’ NEEDS

We can roughly sort the needs of the network operators into three classes

The first class of needs for network operators is planning the operation activities and organising them. Medium term traffic forecasts are necessary (in the order of one year) in order to identify peak days and plan specific measures such as:

- banning specific traffic (e.g. transport of goods)
- banning roadworks during these periods
- mobilising human resources (traffic operators, Police forces, …)
- implementing special operations.

These traffic forecasts are also used for preventative information for drivers: Europe and particularly France have developed “traffic calendars” since the end of the 1970’s (e.g. Bison Fûté calendar created in France in 1978 and the Ferientzmodel calendar in Germany). This preventative information allows travellers to select the most appropriate days for holiday travel.

The second class of needs of network operators is the ability to take into consideration modifications in travel patterns at the last moment (e.g. the week or the day before) and introduce the required corrections in the prepared plans.

The third class of needs is the ability to react in real time to unforeseen events (incidents, accidents, etc) and to implement traffic control strategies to respond to these events. In this case, traffic forecasting can also be used to simulate various control strategies and select the best one.

3. DRIVERS NEEDS

Drivers needs can be classified according to the same classes (planning travel, modifying plans due to unforeseen events, modifying route during the course of travel), but these needs should be seen differently according to the journey purpose. In the following, we present some examples of driver categories with different needs:

3.1 Commuters

For commuters, travel planning is generally made once, so long as the workplace, the home and the transport supply are not modified.

Commuters needs are then related to any potential modification that can affect their usual route: they are particularly interested in the consequences of any foreseen event (weather, roadworks, strikes, demonstrations, etc) that can modify the traffic. In that case, they would like to have enough information to determine whether they have to change their plan: e.g. departure time, itinerary, expected delays, or change of travel mode.

They are of course also interested in any event occurring during their journey and the consequences on their trip: expected travel time and route choices are of primary importance in that case. In general, commuters' routes present numerous alternative solutions, therefore comprehensive real time information on all these alternatives are required by the drivers.

3.2 Leisure travellers

Concerning leisure travel (most of which is long distance travel), needs are quite different, particularly if the planned trip is to occur in an unknown region. Trip planning is thus of primary importance, and the consequences of any event that can affect the plans are important.

During the journey, the drivers of course need to be informed of any disturbance, but in addition more detailed information on alternative choices are necessary as the driver is unfamiliar with the road network. A major difference with commuters is that long distance travellers require accurate information on the main alternative axis.

3.3 Commercial drivers

This category includes different types of drivers: delivery services, long distance goods transport, salesmen, etc. According to their domain of action (long distance, regular circuits, variable circuits in a well-known area, deliveries in unknown area, ..) the needs will be different.

Travel planning will be then important for some types of professional drivers, while real time information on events and their consequences on route choices will be the priority for others…

4. TRAVEL TIME INFORMATION

Travel time is an emerging issue in all developed countries: it is a growing demand from the drivers and is attracting a strong level of interest from many traffic operators and service providers.

However travel time provision requires a high quality data collection and expertise in processing and prediction, most of which are hopefully becoming available now. With the development of the information society, several media are can be used for disseminating information: from variable message signs on the roads to websites and SMS services.

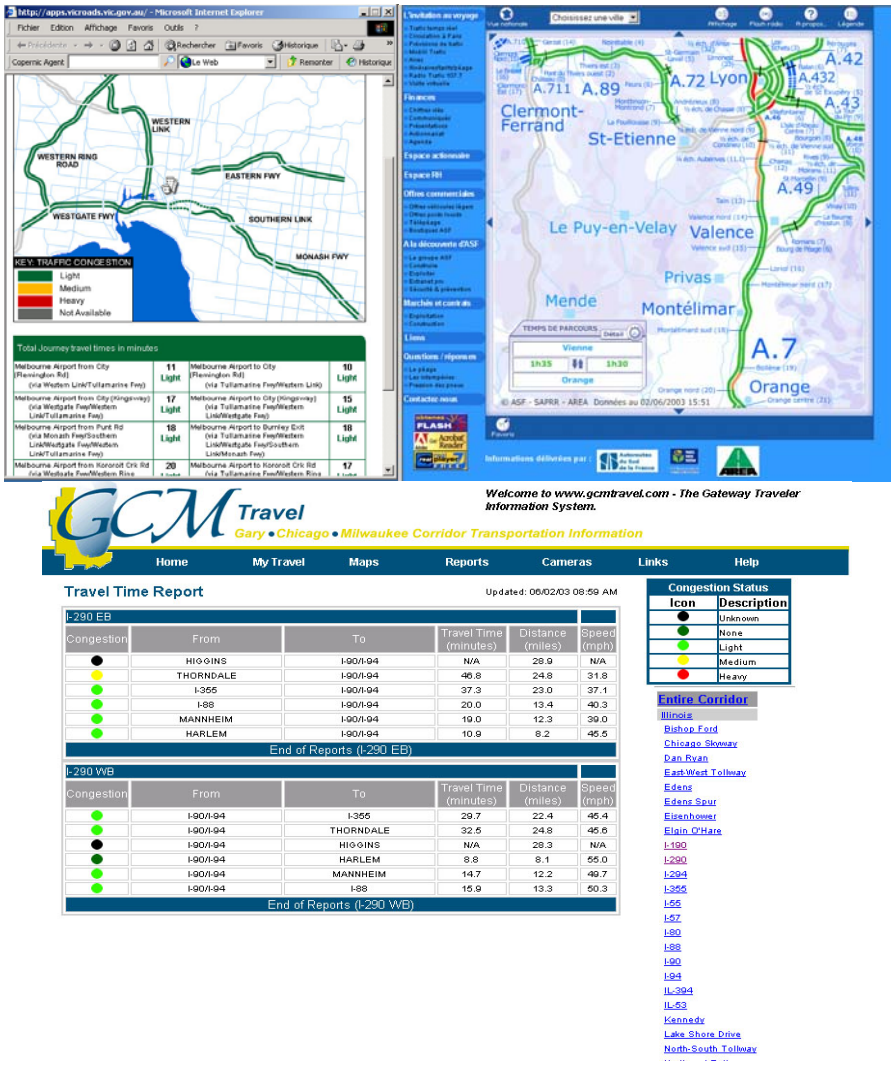

Figure 1 : examples of travel time information on the Web: Vicroads (AUS), ASF motorway (FR), Gary–Chicago– Millwaukee Corridor (US)

Services in operation for several years and large-scale demonstrations particularly in Europe have shown a very high level of user satisfaction.

With the technologies available and the strong level of interest, travel time seems to be a challenge for Europe, and is likely to become a future success story (Waldner, 2001). This statement can certainly be extended to all developed countries.

5. TRAFFIC FORECASTING TOOLS

5.1. LONG TERM FORECASTING TOOLS

We understand by long term forecast the traffic prediction necessary for transport planners: building new infrastructure, widening existing roads, etc. Of course, these forecasts may also serve network operators as they should be considered in the general traffic trend (structural evolution), but they do not respond to the exact needs of network operators which require knowledge of the detailed distribution of traffic in time (days, hours..) and in space (particular zones or stretches of roads,…)

5.2. MEDIUM TERM

These traffic predictions are based generally on historical data, using the following steps:

- identification of comparable periods, networks or situations;
- identification of factors likely to skew comparisons (creation or closure of road infrastructure, changes to police measures, special popular events, etc);
- survey of corresponding traffic flows;
- application of corrective factors;
- development of forecasts;
- determination of the margin for error in traffic estimates;
- comparisons with any forecasts produced by other services

The same type of methodology may be used to update recurrent forecasts on hourly peak periods in a day or peak days in a week, etc.

More sophisticated methodology have been developed, based on statistical analysis of historical data (typology analysis, cluster analysis, etc) and consideration of external variables that may influence traffic patterns.

One important aspect to be considered in these approaches is the quality of the historical data that are used:

- method of completion of missing data;
- interpretation of data: in case of congestion, it should be noticed that traffic counts do not reflect the level of traffic demand and could therefore be misinterpreted;
- Incidents, exceptional events and weather can influence traffic data…

It is the essential that before using the above-mentioned tools, attention is paid to the nature and quality of data used.

Regarding medium term traffic forecast, it is generally stated that the tools available meet the needs of both operators and travellers quite well. In particular, numerous websites are now disseminating the traffic level predictions and advice concerning departure time, including the announcement of exceptional events and consequences. However, this kind of information remains at a quite general level (e.g. expected traffic density in qualitative terms or colour codes) and no route planner service including detailed forecast is operating at a large scale today.

5.3 SHORT TERM

Concerning short-term traffic forecasts, the situation should be seen differently in urban areas and on interurban motorways. In urban areas the density of traffic count sites is high, journey times are relatively short, and the traffic structure is stable, so travel time predictions can be made more reliably.

On inter-urban motorways, the situation is different: average trip lengths are much longer, (and the chance of encountering an incident during the journey is therefore higher), individual driving speeds vary considerably (which affects overall journey time on long trips), there are variations in the traffic conditions between times of day and days of the week, and last but not least the density of data collection is less.

5.3.1 Urban areas

In urban areas, many different techniques have been used to predict traffic evolution at a short-term horizon (one hour in general). Some recent examples: Cologne in Germany, with the use of a so-called “fitted template technique” (base on historical traffic patterns) in comparison with neural networks (Rosswog et al, 2000), Chicago with the use of neural networks, (Zhou et al, 2002).

But despite the numerous research efforts accomplished in this domain, it seems today that in urban areas, the advantages obtained from the viewpoint of the drivers, in comparison with provision of current travel time information is tiny. Therefore network operators disseminate actual measured (or estimated) travel times, which are viewed very positively by drivers.

As an example, we can refer to the extensive evaluation of the travel time information displayed on the Paris Boulevard Périphérique (Boudes, 1997):

Three types of evaluation have been undertaken since the travel time strategy implementation:

- Accuracy of information
- Evaluation with comparison of “congestion information strategy”
- User satisfaction.

5.3.1.1. Accuracy of Information:

Comparison of measured travel time with floating car data information revealed a difference less than 1 min (up to 25 min travel time) and less that 5 min (from 25 min to 45 min travel time).

5.3.1.2 Comparison with "Congestion Information Strategy":

The comparison was undertaken between 22 days with travel time info and 25 days with congestion information. The analysis of the detailed traffic data undertaken during a three-month period has shown that with travel time information:

- An increase of 2.7% of the time spent on Périphérique, and a reduction of 1.9% on Maréchaux (inner urban boulevard)
- Approximately the same distances travelled
- A reduction in the number of vehicles exiting, especially during congestion conditions.

5.3.1.3. Survey on User Satisfaction:

Drivers that have been interviewed stated the following concerning travel time information:

- Is very useful (for 71%), rather useful (for 22%)
- Meets their expectations (84%)
- Improves their comfort (75%)
- Allows them to adapt their itinerary (79%).

5.3.2 Interurban networks

On interurban highways and motorways, short-term traffic prediction has also been studied but real implementations are quite rare. Some examples can be given:

- the OPERA system in Scotland
- the MAESTRO system in France, in operation on the SAPPRR motorway network.

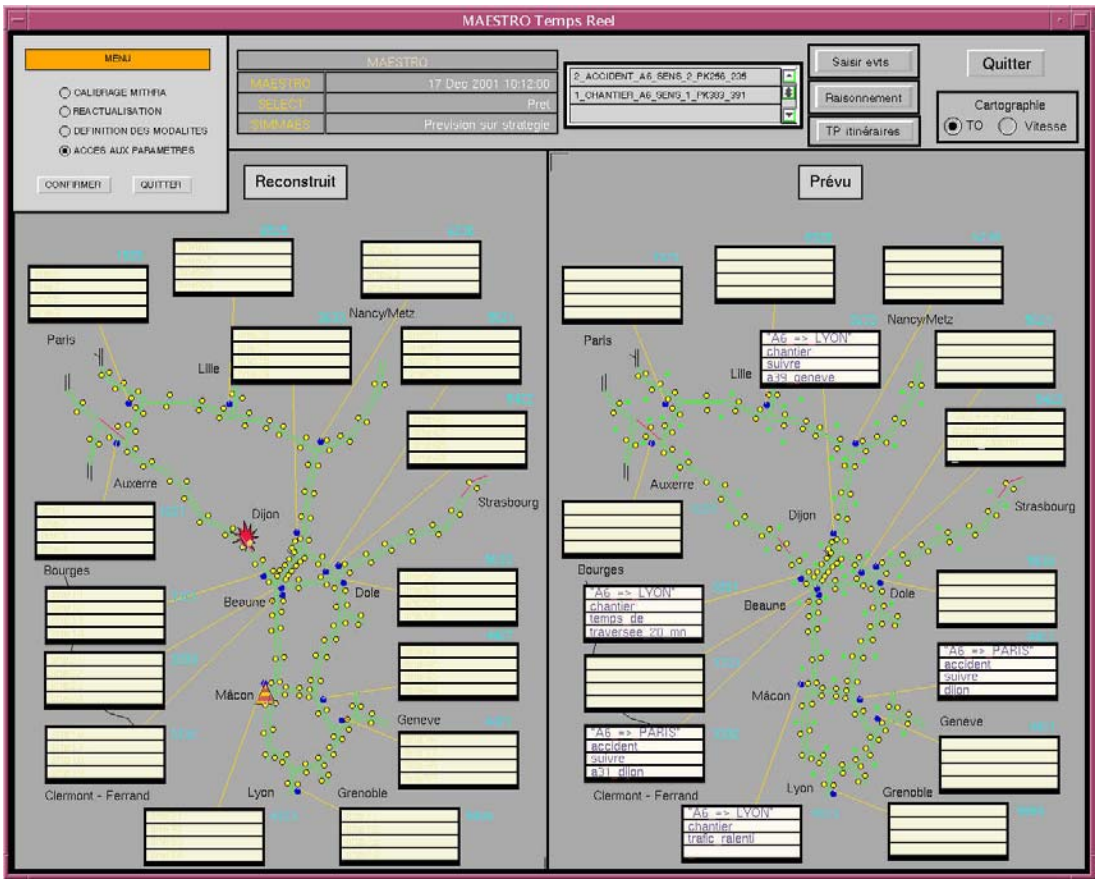

Figure 2: MAESTRO IHM

Both systems are based on the same principles and a 3-module tool:

- a first module in charge of reconstructing the travel demand and the origin/destination matrices (based on historical data and actual traffic counts)
- A second module is a macroscopic simulation model propagating Origin - Destination streams and routes on the network. It provides current and forecast traffic volume, speed, and travel times, including during incidents. It includes a driver diversion behaviour model and an on-line updating module of the compliance rates.
- A third module with the task of preparing and selecting the best traffic control strategies.

By combining the two approaches, this tool is certainly one of the most advanced operating in real situation at a large scale. It is able to provide 2-hour time horizon forecasts that are updated every 6 or 9 minutes.

For SAPPR that operates a linked network of 1500 km, including 4 network boxes of motorway linking Paris to Lyon and the eastern part of France, MAESTRO allows traffic control strategies to be developed and simulates, for implementation on VMSs (Variable Message Signs) and other media. (Buvat, 2002).

Taking into account the capacity of providing a 2-hour horizon forecast, it then possible to inform drivers, and even to advise them on long distance alternative routes (around 200km).

6. CONCLUSION ON FUTURE NEEDS AND TRENDS IN TRAFFIC FORECAST

From the few examples presented in this article, we can draw some general trends, if not definite conclusions:

- thanks to the improvement in data collection and the existence of longer historical series, tools for predicting traffic situations and in particular travel time, are improving and meet operators and drivers' needs quite well;
- however this improvement is impeded by the changes in driver behaviour: not only modification in social and economic activities, but modifications in travel choices due to the use of information delivered by the prediction tools themselves.

Improvement in traffic prediction tools is then a continuous challenge. In addition, the development of navigation systems requires the delivery of accurate real time and predictive traffic information. Some private service providers are already developing traffic prediction information that will add a new degree of complexity to the traffic management activities.

Another aspect that deserves to be mentioned is that there is poor integration of medium term and short term traffic prediction forecast: in particular there seems to be no tool able to integrate modifications one day or two days before, in medium term forecasting in order to take into account the last changes such as weather or exceptional events, while this appears to be a particular need for both the operators and the drivers.

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