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September 1990

**OBJECTIVE MONITORING
OF THE BENEFITS OF DYNAMIC
ROUTE GUIDANCE:
SURVEY METHODOLOGY**

R Slapa, A D May and P W Bonsall

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ABSTRACT

This paper is one of a series concerned with the SERC Rolling Programme on fundamental aspects of the performance of dynamic route guidance systems, and more specifically related to that strand of the programme which has been conducted in Berlin, in conjunction with the field trial of dynamic route guidance (LISB). This field trial has provided the opportunity to test methods, developed in an earlier study (May and Bonsall, 1988) for assessing the objective benefits gained by drivers receiving guidance. This paper describes the survey method for that study.

A method was developed in which pairs of drivers, one with LISB guidance and one without, travelled at the same time between the same origins and destinations. One set of journeys were those to and from work performed by participants who had been using LISB for some time, and who were paired with student drivers. The others were off peak journeys in the same corridors, travelled by student drivers in pairs.

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1. INTRODUCTION

This paper is one of a series concerned with the SERC Rolling Programme on fundamental aspects of the performance of dynamic route guidance systems, and more specifically related to that strand of the programme which has been conducted in Berlin, in conjunction with the field trial of dynamic route guidance (LISB). This field trial has provided the opportunity to test methods, developed in an earlier study (May and Bonsall, 1988) for assessing the objective benefits gained by drivers receiving guidance. This paper describes the survey method for that study.

In order to evaluate the objective user benefits of LISB, it was decided to carry out a journey time comparability study in four different corridors of the street network in Berlin (West). Each corridor was to be surveyed within a one week period.

The first survey round was conducted from 25 June to 6 July 1990 before summer school holidays began on 12 July. During these two survey weeks two radial corridors were surveyed; these were:

Corridor 1: From North to City	(25-29 June)
Corridor 2: From South-East to City	(2-6 July).

The second survey round was planned to be held in September 1990 after the school holidays had ended.

For each corridor a set of eight drivers were selected driving in pairs between specified origins and destinations; one was following LISB advice whilst the other used the route he or she would normally use.

On each corridor the drivers were recruited from four experienced LISB users driving regularly from home to work and work to home, and from four survey staff who were students from the Technical University of Berlin.

The LISB experienced respondents were selected from a subset of 98 people who already had participated in an earlier ITS questionnaire survey held in February and September 1989 (Slapa and Bonsall, 1990).

In each corridor the four selected LISB respondents were shadowed on their daily journeys (from Monday to Friday) to and from work by students who were also driving with equipped vehicles between the same origin and destination, timelagged by about one minute in order that they would not be influenced by the route choice of the other vehicle. Between these journeys in the morning and afternoon peaks with the LISB respondents, the four students were driving in pairs on further off peak journeys with different origin and destination areas within the surveyed corridors.

2. THE BASIS OF THE SURVEY METHOD

2.1 Initial Proposals

The original basis for the method for measuring the true benefits of dynamic route guidance was developed as part of an earlier contract for the Transport and Road Research Laboratory (May and Bonsall, 1988). Briefly, it involved using a test to shadow the vehicle of a participant in the pilot. This was envisaged to be done as follows.

On day one the participant vehicle would operated without guidance, alongside a test vehicle using guidance. Since the test vehicle would attempt to follow guidance completely, the pair of trip times obtained would provide the difference between a vehicle obeying all guidance instructions and one not using guidance at all.

On day two the participant vehicle would operate under guidance, while the test vehicle followed the participant's route of the previous day. The participant would be instructed to use his discretion as to when to follow the guidance. He would follow it only when or where it seemed to him to provide the best choice. If a ratrun seemed preferable, it should be used. The pair of trip times obtained would provide a comparison between origin-destination times without guidance and times between the same points under not perfect but real-world use of guidance. The trip by the test vehicle following the intended route might not be a perfect representation of the route a participant would have followed without guidance, because had the participant been driving on that day, he might have amended his route in response to real-time traffic conditions. But it should be possible to confirm with the participant whether or not he would have used the same route given the actual conditions. This was therefore considered a minor flaw.

It was envisaged that one could thus obtain both maximum potential time savings from the use of the guidance being offered and realistic estimates of likely savings in normal use. This information is clearly of central significance to the evaluation and it was considered that only by using the test vehicles in this way could accurate estimates be obtained. It was considered that a pool of between 8 and 16 test vehicles would be needed, depending on whether one were to include both "perfect" and "realistic" adherence to advice.

2.2 Development of the Method

Based on these initial proposals, discussions were held with the consultants involved in evaluation of the LISB trial in Berlin, SNV, to identify any other requirements of, or limitations imposed by the LISB field trial. This led to a draft specification, incorporated as Appendix 1. This proposal focused on the testing of the method, while providing SNV with a method which, if it proved successful, could be applied more fully for their purposes. In practice, they agreed to co-finance the full survey, with ITS contributing 25% of the cost and SNV 75%. Further development of the method thus incorporated the two objectives of testing the method and contributing to the evaluation of LISB. In addition, the opportunity was taken to design the overall method to allow study of some aspects of the behavioural and attitudinal responses of those involved in the experiment.

In practice, a few further changes had to be made in the proposed method, largely for practical reasons. These mainly concerned the treatment of sampling to cover different driver characteristics. The process of identifying participants among LISB users meant that it was not possible to select some drivers who habitually used main roads, and some who did not. Equally, the selection process for volunteers was unable to treat the issue of route selection as had been intended; it did, however, identify pairs of volunteers with more and less familiarity with the corridor. The other significant variation was the decision not to attempt to involve the LISB users in making any off-peak, less familiar, journeys to avoid making undue demands on them. This meant that no direct assessment of the benefits to experienced LISB users of LISB guidance for unfamiliar journeys was possible. Instead, this issue was treated by involving the volunteer drivers in off-peak journeys. It was originally intended to ask them to identify familiar and unfamiliar journeys in the corridors; in practice, as noted in Section 4.1, this procedure was further modified in the interest of survey logistics.

3. SURVEY CORRIDORS AND DRIVER SELECTION

3.1 Survey Corridors

Four corridors (two radial and two orbital) were selected within the network of Berlin (West). The two radial corridors surveyed, shown in Figure 1, cover the area from North to City (corridor 1) and from South-East to City (corridor 2). The final selection of the other two corridors intended to be surveyed in September 1990 has not yet been made.

3.2 LISB Participants

From an earlier ITS questionnaire interview (Slapa and Bonsall, 1990), the origin and destination areas of 98 LISB respondents were identified, based on the home and work addresses of their regular journeys. From this interview 18 respondents were identified in each corridor whose regular journeys from and to work lay in the two selected radial corridors. All of these 36 potential respondents were then asked by an invitation letter whether they would like to participate in the surveys on objective monitoring, also giving them some information of survey details and intended timetabling. This letter is shown in Appendix 2.

Six respondents in corridor 1 and nine respondents in corridor 2 expressed an interest in supporting the surveys, giving response rates of 33% and 50%. From this subset, four LISB experienced respondents were selected for each of the two corridors surveyed.

The selection criteria were that the respondents should have non-stop journeys from or to work, with no further subdestinations on their way, and should drive regularly from Monday to Friday.

The next procedure was to get in touch again with the respondents to inform them about their survey functions in more detail. This was done by letter including instruction forms and also by telephone calls to confirm the time when they normally start their journeys from home and from work to plan the timing of the journeys. The letter is shown in Appendix 3.

3.3 Other Drivers

The drivers without LISB experience were recruited from students with the help of the Technical University of Berlin's students job service (TUSMA). They were invited to a meeting at the Institute for Road Research and Transport Planning at TUB when general information about the survey methods and background was given and discussed. The prepared instruction lists and general notes about the surveys were handed out to the students explaining the detailed survey procedures as described in Section 4.3. After this general introduction the students were asked about their knowledge of, and familiarity with the street network in the first two corridors intended to be surveyed. This was done to organise the driver pairs in such way that one driver was familiar whilst the other was less familiar with the street network in the surveyed corridors. The eight students were then divided into two groups having one team for the first survey week in corridor 1 and the other for the second week in corridor 2.

On the Friday before each of the surveys began the four equipped vehicles were allocated to the drivers of each team, with explanations of the different features and functions, and use of the Guidance System. It was intended that the students should then use the vehicles over the weekend to gain familiarisation with LISB, and also to get experience with handling the tape recorders to collect detailed information of their journeys en route.

KEY: a LISB user home address

4. SURVEY PLANNING

4.1 Selection of Origin and Destination Areas within the two Radial Corridors

Whilst the locations of the home and work addresses were pre-determined by the LISB respondents, the remaining off-peak journeys were specified by different origin and destination locations within each of the corridors surveyed.

The initial proposal for selecting the off-peak journey locations was that the students should specify two journeys; one a journey which they made regularly in a familiar area and the other a journey in an area with which they were less familiar. In practice the time for planning the surveys in order that they could start before the school holidays began did not permit this approach. Instead, the origins and destinations were defined on the basis that a substantial number of route alternatives should exist between the specified origin and destination areas.

The journey locations are shown on the maps in Figures 2 and 3 for each of the corridors surveyed. A similar overview of these locations within the LISB street network is shown in Figures 4 and 5 demonstrating the possible route alternatives when following LISB advice.

4.2 Logistics of Journeys

The basic concept of the method used should involve a comparison of journey times taken by a driver following LISB advice with that taken by a driver who is making the same journey at the same time using his or her normal method of route finding.

Each set of weekly runs within a specified corridor involved 10 (5 out and 5 return) for each LISB experienced respondent L1 . . . L4 which were each compared with 10 runs by a non LISB experienced student driver V1 . . . V4, and 20 off-peak runs (4 per day) for each of the student drivers which were compared one with another (V1 with V3 and V2 with V4).

These were designed in such a way that each driver would make some of his or her journeys using LISB. While doing so, it was considered appropriate to compare performances of those with more and less experience of LISB, and to divide the week roughly equally between LISB and non-LISB use. For these reasons, the procedure of whether or not drivers should follow LISB advised routes was always the same on Mondays and Fridays, and the reverse on Tuesday, Wednesday and Thursday. The plan for the timing of journeys and allocation of LISB guidance is shown in Table 1.

Drivers who were instructed not to follow LISB advice were advised to use their own "normal" route finding procedure and no attempt was made to constrain any driver to follow any particular route. Also, drivers were not constrained from varying their routes over the week; they were allowed to change their normal routes whenever they considered it appropriate.

Key:

Key:

Home Loc. of LISB - Respond	L1 - L4
Work Loc. of LISB - Respond	L1 - L4
Origin of Journey, Volunteers	V1 - V4
Destination Journey, Volunteers	V1 - V4

FIGURE 4: SURVEY LOCATIONS OF CORRIDOR 1 WITHIN THE LISB NETWORK

Home Loc. of LISB - Respond	L1 - L4
Work Loc. of LISB - Respond	L1 - L4
Origin of Journey, Volunteers	V1 - V4
Destination Journey, Volunteers	V1 - V4

FIGURE 5: SURVEY LOCATIONS OF CORRIDOR 2 WITHIN THE ISB NETWORK

Table 1: Journey Logistics

Monday to Friday

N ^o of journey with approximate timing	Route Finding with LISB		without	Route Finding LISB		with	without
	LISB	LISB		LISB	LISB		
1st 6.00-7.00	L1	↔	V1	L2	↔	V2	
				L3	↔	V3	
				L4	↔	V4	
2nd 3rd 7.30-9.30	V1	↔	V3	V4	↔	V2	
				V1	↔	V3	V2
4th 5th 10.00-12.00	V3	↔	V1	V2	↔	V4	
				V3	↔	V1	V4
6th 15.00-17.30	L1	↔	V1	L2	↔	V2	
				L3	↔	V3	
				L4	↔	V4	

Tuesday to Thursday

1st 6.00-7.00	V1	↔	L1	V2	↔	L2	
				V3	↔	L3	
				V4	↔	L4	
2nd 3rd 7.30-9.30	V3	↔	V1	V2	↔	V4	
				V3	↔	V1	V4
4th 5th 10.00-12.00	V1	↔	V3	V4	↔	V2	
				V1	↔	V3	V2
6th 15.00-17.30	V1	↔	L1	V2	↔	L2	
				V3	↔	L3	
				V4	↔	L4	

On Mondays and Fridays after the daily journeys were finished each of the volunteers V1-V4 were asked to complete questionnaire forms to record their general assessment of their route choice behaviour. Two questionnaire versions were used before and after drivers had gained experience of LISB; these were identical to those already applied in a questionnaire survey of LISB users' route choice behaviour (Slapa and Bonsall, 1990). These questionnaires related to student drivers' impressions on their journeys when LISB was not used on Monday (before version) and on the same journeys on Friday (after version). They were related in each case to the first (morning) journey with the LISB respondents, and the second or fourth journey made with another student driver. In addition to obtaining impressions of LISB, these questionnaire interviews were intended to document any change of drivers' route choice behaviour between Mondays and Fridays, possibly caused by their experience of using LISB advised routes from Tuesday to Thursday.

4.3 Driver Instructions and Duties

4.3.1 General Instructions

Two drivers were required to drive as a pair from specified origins to destinations with one setting off about 60 to 90 seconds after the other. One was to follow LISB advice whilst the other should use his or her own methods for destination finding. In total there were four pairs of eight different drivers. These are four LISB respondents (specified as L1 - L4) and four student drivers (V1 - V4).

Each of the LISB respondents was paired by a student driver on their journey from home to work in the morning peak, and on the way back from work to home in the afternoon peak (i.e. L1 with V1 . . . L4 with V4). Thus there were four driver pairs from Monday to Friday in each corridor surveyed, which would normally produce a total of 40 journey pairs each week.

Each morning after the first journey was completed with one of the LISB experienced respondents, two pairs of student drivers (V1 and V3 and V2 and V4) were then instructed to meet at a new location to carry out their first off-peak journey (journey 2) between a specified origin and destination area.

After this second journey the third journey then involved driving back again in pairs from the off-peak destination to the off-peak origin.

The same procedure was repeated subsequently for the fourth and fifth journeys, which involved driving in pairs between a different pair of origins and destinations. The sixth and last journey of the day for each student driver then involved picking up the LISB respondent at his work location and pairing him or her (again with a 60-90 sec. time lag) to their home.

The gap between the fifth and sixth journey (which lasted normally 3 hours from 12.00 to 15.00) could then be spent for a break, and whenever the student drivers got any more time they were required to start to transcribe their en route recorded data on some of their journeys on prepared forms.

Each vehicle used by both the LISB users and student drivers on the surveys was equipped with:

- 1 tape recorder
- 1 digital watch
- 10 tapes
- 3 battery sets (to change on every 12th journey)
- 1 LISB user-handbook
- 1 ADAC city map (specially printed with X-Y coordinates to enter LISB destination codes)
- 2 sets of each of the two questionnaire versions.

4.3.2 Driving Behaviour

The drivers were instructed to note the following details in determining their driving behaviour:

- drive steadily and move with the traffic stream;
- pay attention to the traffic regulations, especially when driving in streets with speed limits as these can differ between 30, 50 and 80 km/hr;
- driver pairs should start their journeys from the same location to the same destination but time-lagged by about 60 to 90 seconds, making sure that one driver is not being influenced by the other one in his or her own route choice;
- those who are instructed to use LISB should follow its advice (at least on journeys where LISB is being used for the first time), and if not following that advice, state the reason why it was ignored;
- those who were not using LISB, but choosing their own method of route choice, should switch off the keyboard of the guidance system.

4.3.3 Data Collection

The following instructions were used to collect information on the journeys en route by using tape recorders:

1. student drivers should familiarise themselves with handling the tape recorders when driving;
2. before beginning each journey the following information should be recorded at first:
 - driver's name
 - location where the journey is beginning
 - date and time
 - kilometrage of the vehicle;

3. data recording whilst driving en route: (see example on Figure 6 and Table 2)
 - 3.1 passing times when entering specified intersections with the name of the junction passed; such junctions are:
 - a. where the journey direction will be changed to left or right;
 - b. where the journey has to be interrupted at signalised intersections caused by red traffic lights;
 - 3.2 additional information should be recorded on any factors which might have an effect on the journey; such circumstances could be, for example:
 - congestion causing slow driving
 - lanes blocked by parked vehicles
 - vehicle in front driving slowly
 - road works or any other bottlenecks
 - accidents and any other obstructions;
 - 3.3 those drivers who are using and following LISB advice should also record:
 - every item of LISB advice, visual or acoustic, given by the guidance system;
 - every circumstance when the system fails, such as changing from the autonomous mode to the normal mode of guidance or vice versa;
 - every occasion when advice was ignored by the driver, explaining the reason why;
4. when the pre-specified destination is reached by passing a specified screenline:
 - name of destination
 - passing time at destination screenline
 - kilometrage of the vehicle;
5. preparatory information for the next journey.

4.4 Starting Procedures for Planning the Journeys

After general survey instructions were given to the drivers each team of volunteers received further detailed information on every Friday before the surveys within one of the specified corridors began.

The equipped cars used on the surveys were handed out to the student drivers, including all necessary survey equipment (tape-recorders, tapes, batteries, digital watches, LISB-user handbook and a city map) and instructions on how these were to be used. Last but not least each of the student drivers obtained a list shown in Tables 3 and 4 describing the name, sex, car model, home and work addresses, and approximate timing of journeys of the LISB users L1 - L4 to be accompanied by each of the student drivers V1 - V4, and, for the student

drivers, the other pre-selected
origin and destination areas as specified by the name of the intersection.

fig 6

Table 2: Example For Journey Data Collection Transcribed From Tape Recorder

Name der Straßen Kreuzung		Durchfahrtszeitpunkt
1.	Tropfsterne weg 11 (Beginn)	7:21:14
2.	Mariendorfer Damm/Tauernallee (rechts)	7:22:30
3.	Mariendorfer Damm/Alt Mariendorf (Rot)	7:25:05
	Stau, rechte Fahrspur blockiert	
4.	Tempelhofer Damm/Ordensmeister (links)	7:29:12
5.	Ordensmeister/Manteuffelstr (Rot)	7:30:45
6.	Prellerweg/Grazer Damm (Rot + rechts)	7:34:18
7.	Grazer Damm/Vorarlberger Damm (Rot)	7:37:45
8.	BAB/Sachsendamm (links)	7:39:30
	Stau, langsames Fahren	
9.	Hauptstraße/Dominicusstraße (Rot)	7:40:45
10.	Martin Luther Str/Hohenstanfen str (Rot)	7:44:10
11.	Martin Luther Str/Kleiststraße (links)	7:46:00
12.	Kleiststr/Keithstr (rechts)	7:47:10
13.	Keithstr/Kurfürstenstr (rechts)	7:47:45
14.	Kurfürstenstr 118 (ziel und Ende der Fahrt)	7:48:15

After all the details were discussed with the team of student drivers, they were then asked to get in touch via telephone with the LISB respondents over the weekend introducing themselves and to confirm the starting journey times on coming Monday morning.

Those student drivers constituting the pairs of drivers V1 and V3, and V2 and V4 were then also to get in touch, particularly to define the actual beginning and end of their assigned journeys so that each had the same starting conditions for recording the time taken for the journey. These inevitably, could not be the precise locations of the pre-selected intersections but were chosen as a marked place or house number close to the intersection.

Also, the student drivers were then asked to check and adjust the X-Y destination codes of their journeys when using LISB before these were entered and stored via the keyboard memory. Generally, over the weekend, the student drivers were expected to practise with LISB and the other equipment to familiarise themselves.

Each Monday morning when the student drivers met the LISB users for the first time the equipment of tape-recorder, tapes, batteries and digital watches were handed out to the LISB respondents explaining and describing their application. The student drivers also asked for the X-Y coordinates of respondents' home and work locations, and at which specified location the journey should formally end, making sure to have the same starting conditions as respondents' regular journeys.

On every Friday after the weekly surveys within a corridor had been finished the students collected all the tape recorded data from the LISB respondents.

TABLE 3: DETAILS OF SURVEY FEATURES WITHIN CORRIDOR 1

GRUPPE 1: vom 25.6 - 29.6 1990

Name/Car Model		Home/Departure Time	Work/Departure Time
L1	Kurth m	1/28 Forstweg 42 6.15	1/33 Rüdesheimer Str.50 15.00 (17.30 Wed) (12.00 Fr.)
	OPEL OMEGA		
L2	Fritzmannm	1/28 Im Wiesenbusch 15 6.00	1/31 Hohen Zollern- damm 45 15.00 (14.00 Fr.)
	OPEL OMEGA		
L3	Hauser m	1/27 Bernstorffst. 11 6.30	1/10 Salzufer 5-10 16.20 (14.15 Fr.)
	FORD ESCORT		
L4	Rieke f	1/51 Humboldtstr.92 6.30	1/15 Ludwigkirch- platz 3-4 15.45 (14.45 Fr.)
	OPEL KADETT E		
V1	Freidoan m (VW-Passat) VW-Golf	1/12 Goethestr./ Steinplatz Ab ca. 7.30-8.00	1/26 Oranienburger Str/ Eichborndamm Ab ca. 8.15-8.45
V3	Moradi m VW-GOLF	1/41 Kaisereiche = Saarstr./ Dickhardstr. Ab ca. 9.30-10.00 An ca. 10.45-11.15	1/51 Kopenhagener Str/ Klemkestr. Ab ca 10.15-10.45
V2	Genc f DB 230 E	1/30 Pallastr./ Maaßenstr./ Ab ca 7.30-8.00	1/27 Gorkistr./ Mirastr. Ab ca. 8.15-8.45
V4	Gürdal m VW-Passat	1/30 Badische Str./ Mehlitzstr. Ab ca. 9.15-9.45 An ca. 10.30-11.00	1/65 Osloer Str./ Schwedenstr. Ab ca. 10.00-10.30

TABLE 4: DETAILS OF SURVEY FEATURES WITHIN CORRIDOR 2

GRUPPE 2: vom 2.7 - 6.7 1990

Name			Home/Departure Time		Time
Work/Departure					
L1	Teich	m	1/49	Kronacher Str.34 5.55	1/15 Kurfurstendamm 193/19u 16.00 (14.00Fr.)
DB 230 E					
L2	Peske	m	1/49	Buckower Chaussee 4 9.00	1/65 Badstr.10 16.00
NISSAN SUNNY					
L3	Schwartz	m	1/51	Lubener Weg 37 6.30	1/98 Culemeyerstr.1 15.30
FORD SIERRA					
L4	Neumann	m	1/47	Tropfsteinweg 74 7.30	1/30 An der Urania 12-14 16.00 (14.00 Fr)
HONDA ACCORD					
V1	Bunke		m	1/48 Matienfelder Allee/Nahmitzer Ab ca 7.30	1/65 Mullerstr/ Schulstr ab ca 8.30
DB 230 E					
V3	Saky	m	1/47	Buschkrugallee/ Parchimer Allee Ab ca 10.00 An ca 11.15-11.45	1/15 Rankestr/ Augsburger Str Ab ca 10.45-11.00
VW-PASSAT					
V2	KOLB		m	1/21 Sickingen Str/ Wiebestr Ab ca 10.15	1/47 Buckowe Damm/ Mohtimes Allee Ab ca 11.15
VW-GOLF					
V4	Gurdal	m	1/12	Steinplatz/ Goethestr Ab ca 12.30 An ca 13.45	1/49 Halker Zeile/ Kettinger Str Ab ca 13.15
Genc f					
FORD GRANADA					

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