

Development of a  
Comprehensive Vehicle Instrumentation Package  
for Monitoring Individual Tripmaking Behavior

Literature Review

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## Literature Review Overview

This document contains a selection of research literature relevant to different aspects of the Electronic Travel Diary. Each reference includes the title, the publication, the author(s), and the abstract (if available and /or applicable). The objectives of this literature inventory include:

1. To research past state-of-the-practice travel diary survey methodologies. This research includes the analysis of both interactive and automated data collection methods, as well as the more traditional manual methods, in order to design an instrumentation system optimized to gather all feasible and relevant data while minimizing data collection errors and omissions. Driver procedures for system use will also result from analysis of this research. Sections include:
  - **Travel Diaries: Manual Data Collection Methods (PAPI)**
  - **Travel Diaries: Interactive Data Collection Methods (CATI)**
  - **Travel Diaries: Automated Data Collection Methods (CASI)**
2. To research trends within the field of travel behavior research. Sections include:
  - **Trends in Travel Behavior Research**
  - **Stated Preference Surveys**
  - **Selection of Travel Surveys and Studies**
3. To gain knowledge of other vehicle instrumentation studies and/or related technologies available for transportation analysis. Sections include:
  - **Instrumented Vehicle Studies**
  - **Other Transportation-Related Technology Applications**
4. To investigate driver and vehicle selection processes and methods used in past research efforts. This investigation will aid the research team in identifying successful driver solicitation strategies and promising sampling techniques. This research will also examine the effectiveness of monetary participation incentives. In addition, this research will assist in the stratification of drivers to be selected in Atlanta to obtain an unbiased sample. Sections include:
  - **Survey Bias and Response Rate Issues**
5. To explore human factors elements of instrumentation. This will enlighten the research team as to potential impacts or nuances to ensure effective design of the on-board vehicle instrumentation package. Most of the research documented in this area is in the field of ATIS (Advanced Traveler Information Systems) – more specifically in the area of route choice / route guidance systems.
  - **Route Choice / Driver Information Preferences**

A list of selected manuals, reports, journals and conference proceedings which are dedicated to travel surveys or travel behavior is provided at the end of this document.

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## BOOK 1

### Travel Diaries -- Manual Data Collection Methods (PAPI)

**Title: Survey Approach for Study of Urban Commuter Choice Dynamics**

**Pub:** TRR 1412, 1993, pp. 80-89

**Auth:** Hani Mahmassani, Thomas Joseph, and Rong-Chang Jou

**Abstract:** A methodology to capture the day-to-day dynamics of user behavior in a commuting context is described. A two-staged survey was designed to obtain detailed information on the commuting habits in the north Dallas area for an extended period of time. In the first stage of the survey a one-page two-sided questionnaire was sent to 13,000 households in the selected area. Information from the first stage provided a reliable characterization of the population of interest and prevailing commuting patterns. The second stage involved respondents of the first stage who were willing to provide more information on their commuting habits. This stage was considerably more detailed, consisting primarily of an activity diary limited to the commuting trips from home and returning to home. It included information on trip chaining, departure time, and path choice, and a level of detail previously unavailable. The information was for a period ranging from 1-2 weeks. The two-staged format proved to be a cost-effective and practical method of obtaining the kind of information needed to study the dynamics of commuting behavior.

**Title: The Design and Administration of Mail Surveys**

**Pub:** Annual Review of Sociology, Vol 17, 1991, pp. 225-249

**Auth:** Don A. Dillman

**Abstract:** For reasons of cost and ease of implementation, mail surveys are more frequently used for social research than are either telephone or face-to-face interviews. In this chapter, the last two decades of research aimed at improving mail survey methods are examined. Discussion of this research is organized around progress made in overcoming four important sources of error: sampling, noncoverage, measurement, and nonresponse. Progress has been especially great in improving response rates as a means of reducing nonresponse error. Significant progress has also been made in finding means of overcoming measurement error. Because mail surveys generally present few, if any, special sampling error problems, little research in this area has been conducted. The lack of research on noncoverage issues is a major deficiency in research to date, and noncoverage error presents the most significant impediment to the increased use of mail surveys. The 1990s are likely to see increased research on mail surveys, as efforts are made to incorporate mail into cost-effective mixed mode designs.

**Title: A Comparison of Telephone and Door-to-Door Survey Results for Transit Market Research**

**Pub:** TRR 1144, 1987, pp. 87-91

**Auth:** Robert A. Hitlin, Frank Spielberg, Edward Barber, and Stephen J. Andrie

**Abstract:** Any sample survey design involves a trade-off between funds available, sample size desired, and degree of precision required. Early in 1986, the Northern Virginia Transportation Commission sponsored a research project in Northern Virginia conducted by Robert Hitlin Research Associates, Inc., and SG Associates, Inc., to estimate demand for two proposed transit services. The two companies developed an estimation technique based on door-to-door sample surveys and small-scale telephone surveys. In this paper, the costs, findings, and advantages and disadvantages of the two types of data collection are compared. The telephone survey was approximately three and one-half times as expensive per interview as the door-to-door survey, but the results of the two surveys were virtually identical in each location. There were major differences in ease of administration, speed, required personnel, and other factors that may determine which approach to use in the future. A self-administered, door-to-door survey with a large enough sample size to allow analysis at the subarea level and therefore narrow in confidence intervals, which costs considerably less than a telephone survey, is a cost-effective and viable option.

**Title: Mail-Out/Mail-Back Travel Survey in Houston, Texas**

**Pub:** TRR 1097, 1986, pp. 13-19

**Auth:** Alan C. Clark and Celia Goldstucker

**Abstract:** During the fall of 1984, a mail-out/mail-back travel survey was conducted on Houston area households. Designed to obtain household, tripmaker, and detailed trip characteristics, the survey was completed by 1596 of 6941

households contacted by telephone. The procedure used was to telephone selected households and request their participation. A survey form was mailed to each participating household on which each trip made by members of the household for a given day was recorded. The forms were then returned by mail and analyzed. The mail-out/mail-back survey procedure was chosen because it best met the constraints of project funding, time available, for data collection, data needs, and staff availability and training. Based on statistical evaluation of the quantity and variability of travel by household type, it was determined that reliable estimates of tripmaking characteristics could be obtained with a stratified sample of 1200 households. Although tending to under-represent household categories with small percentages of the total population, the sample was representative of the population in those household categories with the greatest proportions of Houston area travel.

**Title: Use of an Activity Diary Survey to Examine Travel and Activity Reporting in a Home Interview Survey: An Example Using Data from Adelaide, Australia**

**Pub:** Transportation, Vol 13, no 4, 1986, pp. 329-357

**Auth:** P. O. Barnard (Australian Road Research Board)

**Abstract:** Research presented in this paper uses results from an activity diary survey to comment on the quality of data collected in a home interview travel survey. The two surveys were conducted in Adelaide, Australia. Evidence is presented to suggest that although a period of slightly more than three years separated the two surveys, the samples were reasonably similar with respect to their socio-demographic composition and real mobility levels. There was, however, a much higher level of travel and out-of-home activity reporting in the activity diary when compared to the home interview survey. Differences in reporting rates are examined in detail and areas of deficiency with the home interview survey are identified. The paper concludes with a short discussion of the possible implications of these deficiencies when home interview survey data is used to investigate a range of urban transport issues.

**Title: Nationwide Personal Transportation Study: Experiences with Previous Surveys and Options for the Future**

**Pub:** TRR 1097, 1986, pp. 31-33

**Auth:** Susan Liss

**Abstract:** The Nationwide Personal Transportation Survey (NPTS) is a survey of travel patterns of U.S. households, with a focus on the amount and nature activity. The survey provides a benchmark of travel activity and a measure of the impact of selected demographic factors on travel patterns. The survey was conducted in 1969, 1977, and 1983, with the next survey in the series scheduled for 1988. The surveys conducted to date have been home-interview surveys, but there are current plans to conduct a telephone survey in 1988. Some of the factors pointing to the use of a telephone survey are (a) decreased cost per interview, (b) expanded sample size, and (c) centralized interviewing, and (d) the capability of on-line editing. Balancing these advantages are concerns of comparability with the previous surveys, biases inherent in telephone surveys, and whether the overall length and complexity of the data are appropriate for telephone interviewing. Despite these concerns, the telephone methodology will most likely be used for the next NPTS. Telephone surveys are the predominant method of conducting travel surveys today, probably because they provide acceptable response rates at a low unit cost and have the benefit of personal contact with the household.

**Title: Collection of Household Travel and Activity Data: Development of a Survey Instrument**

**Pub:** New Survey Methods in Transport, VNU Science Press, Utrecht, 1985, pp. 151-172

**Auth:** Werner Brög, Arnim H. Meyburg, Peter R. Stopher, and Manfred J. Wermuth

**Abstract:** Transportation planning relies heavily on the collection of data on travel behaviour by households, traditionally collected by recall surveys administered by household interviews. Although almost every major transportation study has relied on this method of data collection, there has been no systematic study of the quality of either the methodology or the resulting data. Yet these determine the validity of the data and, hence the conclusions, policies, and model developed from them. This paper deals with the design of a survey instrument; with a systematic procedure aimed at improving both the quality of the data and methodology, and also in reducing non-responses. The instrument is a diary, designed for an individual to record all travel and related activities for a 24-hour period. The paper describes, first, the process of design of the instrument through a series of tests and developmental surveys in West Germany. Second, the instrument was adapted for use in the US, and the adaptations and improvements made are described. The methods used to field test the survey instrument are described, together with the resulting response rates and characteristics. The most significant conclusion of the paper is that the resulting instruments are applicable not only in the nation and culture in which they were designed originally, but also in other nations, languages, and cultures, adding a major dimension to the assessment of validity of this survey instrument.

**Title: Development of Methodology for Estimating the Kilometrage of Drivers Throughout Quebec**

**Pub:** Conference Proceedings of the Canadian Multidisciplinary Road Safety Conference IV; May 1985

**Auth:** Martin Lee-Gosselin

**Abstract:** In response to the need in road safety research for a low cost method of monitoring the amount and type of automobile kilometrage driven throughout Quebec, RAAQ sponsored a survey development project in 1984. Most of the study effort was directed to extensive pretesting of the only method which met cost constraints – a one-day trip diary, which was completed by the respondent and mailed back to the RAAQ. Based on known trip rates and pilot interviews, it was decided to test special procedures involving 3 or 7 day logs for drivers aged under 20 and over 64 years. Postal reminders were also tested. The study yielded valuable information on response rates, the degree to which different age groups took trip logs seriously, postal delivery times, trip rates, and the attitudes of drivers to being chosen at random to participate. It was concluded that the mailed trip log approach is viable in Quebec if painstaking follow-up of respondents is effected, but that the response rates of 70 to 80% seen in related European surveys are unlikely to be achieved.

**Title: Self-Administered Mailback Household Travel Survey**

**Pub:** TRR 955, 1984, pp.10-17

**Auth:** John P. Poorman and Deborah J. Stacey

**Abstract:** The development, application, and results of a low-cost self-administered mailback household travel survey used by the Capital District Transportation Committee are described. The objective of the survey was to update 1965 home interview survey data. Criteria employed in selecting the survey technique were that the technique minimize both cost and staff effort and that the technique produce usable personal and household travel information across a broad range of socioeconomic groups and geographic areas. Key features of the survey included the survey instrument design, the use of bus tokens and maps as incentives to increase response rates among lower income households, and the use of an interactive computer program for data entry. The selection of the survey technique and design of the survey instrument are described. Two pretests were employed to verify the effectiveness of the survey instrument and of the use of incentives. After review of pretest results, a full-scale (approximately 5 %) sample of 12500 households in the metropolitan area was drawn and the survey was undertaken in March 1983. Results of the pretests and the full-scale survey are discussed, as well as the procedures used to verify accuracy of responses and to enter data into computer files. Costs of each aspect of the survey effort are also described. The survey successfully elicited detailed socioeconomic and travel data with only a modest level of staff involvement and survey cost. Cost per usable survey response was approximately \$14 for 2610 responses.

**Title: Successful Administration of a Mailed 24-Hour Travel Diary: A Case Study**

**Pub:** TRR 987, 1984, pp. 14-20

**Auth:** Eric G. Ohstrom, Joan B. Ohstrom, and Peter R. Stopher

**Abstract:** Recent transportation survey research has shown that successful travel diaries can be constructed, and that these diaries can collect information on travel by individuals for a period of 24 hours or more. The successful diaries are comparatively expensive survey instruments and have been described primarily in terms of use in conjunction with a personal visit by an interviewer. The interviewer may collect some information at the time of the visit, but he plays an essential role in explaining the use of the diary. This interviewer visit has made the diary an expensive survey instrument. A case study of the administration of a travel diary survey conducted through a combination of telephone contact and mail-out, mail-back procedures is described. In the description of this case study it is shown that the diary can be administered successfully by this means, that the results obtained are of a high quality, and that a response rate significantly higher than that associated with most mail surveys can be obtained. A number of details of the administration methods used, which are believed to have contributed to the success of the instrument, are discussed. The procedure described produced a usable response rate of 58.5 percent of the mail sample of households, from which it was possible subsequently to calibrate new trip-generation and modal-split models. Some of the results obtained, including the higher trip rates for non-home-based trips, are described. It is suggested that refinements to the instrument and procedures could generate yet higher response rates.

**Title: Development of Survey Instruments Suitable for Determining Nonhome Activity Patterns**

**Pub:** TRR 944, 1983, pp.1-12

**Auth:** Werner Brög, Arnim H. Meyburg, and Manfred J. Wermuth

**Abstract:** Generation of travel behavior data by means of empirical surveys is an important element of transportation planning. At the same time, relatively little attention has been paid to the rules for collecting and determining the methodological quality of the data. The methodological design of such surveys is relatively complicated because of the number of influence factors that may ultimately be reflected in the validity of the results. The issue of survey instrument design is discussed in detail. A number of methodological tests are examined that were intended to improve one of the weak points in surveys of travel behavior – the design of such instruments. Initially, it was concluded that a diary-type instrument would have to be used to ensure proper recording of trip details. An ideal diary was developed that was used in several surveys. But it became evident that this instrument design, in spite of its high methodological quality, was unsuitable for large-scale surveys, such as those frequently used in transportation planning, because of organizational and cost problems. Therefore, an additional series of tests was developed to simplify these diaries and to transform them into a form suitable for large-scale mail-back surveys. Each test series was tested empirically with the detailed documentation of reporting deficiencies. Thus it was possible to present in an understandable manner the development of a survey instrument of desirable quality. The final version of the instrument design, which was the outgrowth of the empirical tests, has been used subsequently in numerous large-scale applications in several countries. In the course of these applications the methodological quality of the design was confirmed, which ultimately justified the development costs.

**Travel Diaries: Interactive Data Collection Methods (CATI)**

**Title: Use of Direct Data Entry for Travel Surveys**

**Pub:** TRR 1412, 1993, pp. 71-79

**Auth:** Ng and Sargent

**Abstract:** Telephone interviews are a popular way to collect survey information. In the traditional paper-and-pencil method, the interviewer records the responses on paper forms, and later the information is input into a computer file for error checking and further analysis. The quality of the data depends not only on interviewing skill but also on the ability of the interviewer to write legibly, the accuracy of the data entry staff, and the feedback process in reporting ambiguous or incorrect information. Data of higher quality can be obtained by having the interviewer directly enter the data into a computer file as the interview proceeds. Direct data entry would minimize data entry errors while enhancing quality control and the overall processing of the data. The design and use of a direct data entry system in the conduct of a major household travel survey in the greater Toronto area are discussed. Besides obtaining good-quality data, the DDE software also improved sample control, the rate at which interviews were completed, and the monitoring of interviewers' performance and progress. To identify the cost and benefits of direct data entry, extensive comparisons are made with a survey that was similar in terms of survey area and questionnaire design but conducted using the paper-and-pencil method.

**Title: Collecting Complex Household Travel Data by Computer**

**Pub:** Selected Readings in Transport Survey Methodology, Eucalyptus Press, Melbourne, 1992, pp. 283-305  
from 3rd International Conference on Survey Methods in Transportation

**Auth:** Peter Jones and John Polak

**Abstract:** Recent developments in computer hardware and software are making it an increasingly attractive proposition to carry out household travel-related surveys on personal computers, at a time when demands are growing for more sophisticated and complex surveys that tax to the limit the conventional manual, pen and paper methods. With the latest generation of portable computers, it is feasible to interview on-mode as well as in the home... This paper discusses the advantages, and some limitations, of using computers in personal interviewing, and presents a number of examples in more detail. What started out as a method for carrying out conventional interviews in a more efficient and reliable way is rapidly becoming a medium of communication in its own right, opening up new possibilities for inquiring into complex aspects of household travel behaviour.

**Title: Interactive Travel Survey Methods: The State-of-the-Art**

**Pub:** New Survey Methods in Transport, VNU Science Press, Utrecht, 1985, pp. 99-127

**Auth:** Peter M. Jones

**Abstract:** Interactive survey methods exploit the dynamics of the personal interview in order to probe the attitudes, motivations, perceptions, and behaviour of respondents at a deeper level than is possible using a structured questionnaire. To achieve these benefits, however, correspondingly greater skills are required, both during the interview and in the analysis and interpretation of results. The paper considers a number of key methodological features associated with the different forms of interactive technique, including the dynamics of the group discussion, the use of display equipment and the role of gaming simulation. Examples are given of the practical benefits that have been derived from the use of these methods in a number of policy contexts. Three general contexts are identified in which the approach has been applied within a larger transport study, covering exploratory, investigative, and interpretative roles. Although interactive survey methods represent a relatively new approach in the transport context, they have excited considerable interest and offer a means of tackling a number of current issues; there are also dangers of misapplication, however, which the analyst should guard against.

**Travel Diaries: Fully Automated Data Collection Methods (CASI) Specific Projects**

**Title: Handheld PC based travel data collection by self-administered interviewing**

**Pub:** 1998 Association for Survey Computing

**Auth:** Ines Haubold and Kay Axhausen

**Abstract:** The project Technologies of European Surveys of Travel Behavior (TEST) aims to improve current practice of long-distance travel behaviour surveys. The development of a handheld personal computer (H/PC) based travel diary is one part of the TEST project. This paper will describe the design and implementation of a prototype computer-based travel diary application (TDA). The first section will give an overview of the specific task elements of the TEST project which is designed to improve data collection, enrich the data collected and to enhance data quality to increase the cost-effectiveness of the survey work. The arrival of cheap hand-held palmtop organisers provides the opportunity to conduct complex real time travel diary surveys. The second part presents an analysis of the issues involved in selecting and developing appropriate for the travel diary application (TDA). The third section describes the travel diary screen and provides an overview of the data collection items and structure. Finally, first experiences with the travel diary application will be gained by field tests in Austria and Sweden during the spring/summer 1998. The H/PC will be carried by respondents during the pilot survey period, allowing them to record their travel "on-line" in which respondents will have the opportunity to edit their answers every time and everywhere, e.g. before, during or after a journey, at home or office, in train or bus. The acceptability and effectiveness of the field tests are evaluated and presented, focusing in particular on user experience with the system.

**Title: Solutions For Implementing Long Distance Travel Diaries Using Internet Technologies**

**Pub:** TEST Consortium Progress Report, July 1998

**Auth:** John M. Plaxton, Paul G. Jackson, and John W. Polak

**Abstract:** The Imperial College TEST Progress Report of February 1998 (Plaxton et al., 1998) detailed the requirements and possible development problems of a pan-European long distance travel diary implemented using Internet technologies. Technologies were chosen which could meet the demands of the application and which would be platform independent. Using these technologies, a variety of prototype interfaces were designed and constructed to evaluate how best to design a Travel Diary Application using the chosen Internet technologies. This paper reports on the work undertaken since then. It describes the development of a survey tool which allows all the program logic of the application to be embedded in the HTML pages which control the layout of the user-interface. The survey tool was then used to develop an actual Internet Travel Diary Application (iTDA) which is currently undergoing cognitive testing in London to determine the suitability of the design. This paper also outlines what we hope to achieve in the next stage of our work.

**Title: Technology Assessment: Deliverable 1 of Technologies for European Surveys of Travel Behavior (TEST)**

**Pub:** Project report for presentation to the European Commission, June 1997

**Auth:** Ines Haubold, Paul Jackson, Kay Axhausen, and John Polak

**Abstract:** The project Technologies of European Surveys of Travel Behavior (TEST, 1997) aims to improve current practice in surveys of long-distance travel behaviour by means of the application of appropriate new technologies. The first deliverable of the project documents the work carried out during the first work package. This study starts with the investigation of new technologies with regard to their potential for offering improvement in travel diary survey and work and data quality. Different (computer-assisted) data collection methods are compared and assessed, resulting in recommendations to increase the precision of electronic data collection. The second part of this document describes and summarises telephone interviews conducted with German and English professionals involved in travel surveys, based on a questionnaire guide. These are undertaken to establish their travel data needs and their opinions on the use of the various new technologies in this sector (e.g., computer assisted data collection). Further, in preparation of the second work package, special emphasis was given to the identification and selection of the software and hardware required for the development of travel diaries capable of recording real-time travel behaviour data.

**Title: Preliminary Analysis of Portable Activity Diary with GPS Pre-pilot Study**

**Pub:** memos to Jean Wolf, June 1998, November 1997

**Auth:** Geert Draijer

**Abstract:** These memos summarize the Netherlands' 1996 pre-pilot test of automated data collection methods using GPS. The project name is 'Possibilities of Global Positioning System (GPS) for traffic and transport research, pre-pilot phase.' A handheld computer (PSION Workabout) was equipped with a GPS device with antennae (Trimble) to capture trip information across all modes of transport. A total of 83 trips were measured using 'professional' respondents (ie, those who work at the Dutch Transport Research Centre. A new pilot project, elaborating on the pre-pilot but more extensive in scope, begins in June 1998. For this pilot, 'real' respondents will be used, including an extensive non-response analysis. Results are expected by the end of 1998.

**Title: Tracing the Household Activity Scheduling Process Using One-Week Computer-Based Survey**

**Pub:** Preprint Draft Paper for presentation at IATBR, Sept 1997

**Auth:** Sean T. Doherty and Eric J. Miller

**Abstract:** Household activity scheduling has become a topic of considerable interest for travel behaviour researchers. Activity scheduling embodies the interdependent decisions made about which activities to participate in, when, where, for what duration, with whom, and by what mode and route. Past research has focused mainly on the modeling of each of these aspects in isolation, while more recent efforts have attempted to harmonize these decisions into more comprehensive modeling frameworks. Despite the need, very little fundamental research has been conducted into the underlying scheduling process in support of these models. The survey approach presented in this paper attempts to fill this gap. At the core of the survey is a Computerized Household Activity Scheduling (CHASE) program. The program is unique in that it runs on a laptop computer within a household for week-long period during which time all adult household members login daily to record their scheduling decisions as they occur (including choices to add, modify, and delete activities). An up-front interview is used to define a household's activity agenda (a listing of household activities and their attributes) and mode availability. This information is coded directly on computer and is used by the CHASE program to speed and customize data entry. A sample of 12 households (23 adults and 6 children) was used to test the performance of the survey. Analysis presented here focuses on login frequency and durations, scheduling step frequency, weekly activity-travel patterns, and scheduling time horizons. Overall, the results show that the pre-definition of a household agenda, coupled with a computer-based survey design, represents a practical approach to gathering a wealth of information on the underlying process, while minimizing the burden on respondents. The paper concludes with discussion on future analysis and survey design issues.

**Title: Report: Lexington Area Travel Data Collection Test; GPS for Personal Travel Surveys**

**Pub:** Final Report to OHIM, OTA, FHWA, Sept 1997

**Auth:** David Wagner (Battelle, Transportation Division)

**Abstract:** This report summarizes the results of the FHWA sponsored project to develop a small user-friendly, mailable unit including a GPS receiver to capture vehicle-based, daily travel information. The field test was conducted in Lexington, KY in the fall of 1996 with 100 households. One of the benefits of incorporating a GPS device into the survey process was the ability to collect information on route choice and travel speed. While the procedure to match the GPS data points to the transportation network was not easy, improvements to GPS and GIS software should make these application more user-friendly in the near term. The field test was primarily a test of equipment and willingness to participate, rather than obtaining statistically valid travel behavior data. There are limitations to the dataset and analyses that are discussed where appropriate. Recommendations on using enhancements to this technology are made.

**Title: Comparison of CASI Using GPS with Retrospective Trip Reporting Using Phone Interviews**

**Pub:** Draft submitted for Presentation at IATBR, Sept 1997

**Auth:** Elaine Murakami, David Wagner, and David Neumeister

**Abstract:** This report compares the results of the trip data collected using automation (handheld computer and GPS) versus trip data collected using telephone interviews for the same trips. Areas evaluated include accuracy/completeness.

**Title: Using GPS and Personal Digital Assistants for Personal Travel Surveys in the US**

**Pub:** Paper presented at Transport Survey: Raising the Standard; International Conference on Transport Survey Quality and Innovation, May 1997

**Auth:** Elaine Murakami, David Wagner, and David Neumeister

**Abstract:** Preliminary report on field test results.

## BOOK 2

### Trends in Travel Behavior Research

**Title:** Existing and emerging techniques for the automatic collection of data for transport modelling

**Pub:** <http://www.smithsys.co.uk/smith/public/tech/autocoll.htm>, January 1997

**Auth:** B. G. Williams

**Abstract:** (Condensed from the Executive Summary) This report is concerned with sources of automatic traffic and travel data that may be used for transport modelling. The report considers the sources of such data, both current and potential, and how they might be used by existing and future transport models... the report classifies data sources as point data (e.g., loops, infrared sensors), section data (e.g., number plate matching techniques, beacon systems), origin-destination and route data (e.g., vehicle tracking, automated surveys) and pedestrian and passenger data (e.g., in-flow and out-flow of passengers at stations)... Traditionally, origin-destination data have been collected by roadside interviews and travel surveys. The report considers recent advances in computer-based survey techniques and the possibility of using vehicle tracking systems to provide O-D and route choice data.

**Title:** New Data Collection Methods in Travel Surveys

**Pub:** Activity-based Approaches to Travel Analysis, Pergamon Press, 1997

**Auth:** N. Kalfs and Saris, W.E., eds D. F. Ettema and H.J.P. Timmermans

**Abstract:** The amount of information desired from respondents by transportation planners has increased tremendously over recent years. Recently, activity-based approaches have become more favored. In this approach, travel behavior is captured via a travel diary, which is traditionally captured by paper-and-pencil. Diary design can vary based on whether all activities have to be registered or only the movements during a specific period of time, along with all relevant detail. Although the use of a diary is thought to produce the most accurate results, this method is rather expensive and demands a lot of time from both respondents and researchers. These disadvantages, along with advances in computer technology and the fact that non-response rates have increased over the past years, have changed the methods of data collection and have led to the possibility of using alternative data collection techniques, most of which use computer-assisted data collection (CADAC). The popularity of these techniques has grown each year and the use of fully automatic data collection systems – like smart cards and GPS - has been explored in travel surveys. At this moment, the FHWA is investigating the GPS method in a pilot. A review is therefore made of the quality and potential of data collected with these techniques.

**Title:** Current Issues in Travel and Activity Surveys

**Pub:** Resource Paper on Travel Behaviour Measurement, for IATBR, Sept 1997

**Auth:** Tony Richardson

**Abstract:** This paper summarizes findings from the International Conference on Travel Behaviour Surveys, held in May 1997 in Eibsee, Germany. Workshop themes include:

Multi-instrument and multi-method surveys	Questionnaire design
Respondent sampling, weighting, and non-response	Hypothetical situations
Item non-response	Practitioners' future needs
Quality indicators	Modellers' needs
Multiday and multiperiod data	Qualitative survey methods
Respondent Burden	Data presentation

**Title:** Resource Paper for Survey Methodologies Workshop

**Pub:** Conference Proceedings 10 – Household Travel Surveys: New Concepts and Research Needs, 1996

**Auth:** T. Keith Lawton and Eric I. Pas

**Abstract:** The total methodological design of interrelated surveys to provide data for analysis, understanding, and modeling of household and personal activity, time use, and travel behavior is addressed. Evolving trends in models in response to current and emerging planning and policy issues are discussed to set the stage for developing data collection needs. Survey design issues are discussed, and the needs for the cross-sectional, single-day household survey of revealed behavior (revealed preference) are discussed in the context of the availability of other, often more appropriate, methods, namely stated preference/stated choice experiments and multiday, panel surveys. Sampling and sample design are

discussed, first with regard to a single-day survey, then as affected by multiday design and the economies and other benefits introduced by the use of stated preference surveys and longitudinal panels. A brief description of recent and ongoing surveys in the US is given.

**Title: Data Collection Instruments and Related Issues: Workshop Summaries and Research Problem Statements**

**Pub:** Conference Proceedings 10 – Household Travel Surveys: New Concepts and Research Needs, 1996

**Auth:** Workshop Attendees

**Abstract:** Sections within this summary include DATA COLLECTION METHODS AND ISSUES (Data Collection Methods, Data Collection Stages, Data Validation, Geocoding Issues), DATA ITEMS (Income, Vehicle Information, Parking Costs, Ethnicity), RECRUITMENT ISSUES, RESPONDENT MATERIALS (Complexity of Surveys, Activities Versus Trips, Layout and Design, Incentives, Respondent Materials, Materials Used)

**Title: Travel Behavior Survey Data Collection Instruments**

**Pub:** Conference Proceedings 10 – Household Travel Surveys: New Concepts and Research Needs, 1996

**Auth:** Cheryl Stecher, Stacey Bricka, and Leslie Goldenberg

**Abstract:** There exists a tremendous variety in the structure and form of instruments to collect household travel data. The basis for most instruments was the in-home interview used in the 1950's and 1960s. Current instruments reflect changes in data collection methods, from in-home to mailback or telephone retrieval. The amount and type of information desired to be collected have also changed with the requirements of new legislation and the underlying transportation planning and forecasting models. Current issues in household travel survey instrumentation are discussed, including the pros and cons of various approaches, and recommendations for future practice are presented.

**Title: New Technologies: Workshop Summary and Research Problem Statements**

**Pub:** Conference Proceedings 10 – Household Travel Surveys: New Concepts and Research Needs, 1996

**Auth:** Workshop Attendees

**Abstract:** Sections in this Summary include STATE OF THE ART (Computer-Assisted Telephone and Personal Interviewing, GIS Technology, Other Computer Technologies, GPS and ITS, Video/MultiMedia/Virtual Reality), RESEARCH PROBLEM STATEMENTS:

- Using GIS for Developing Standard Land Use Types and for Drawing Spatial/Geographic-Based Samples
- Improving Accuracy of Travel Behavior Information Using GPS
- Integrated CATI and GIS
- Approaches to Improve the Presentation and Understanding of Transportation Alternatives in SP Surveys
- Multimedia-Assisted Interview Research Synthesis on Using GIS Technology in Household Travel Surveys
- Path-Coding with Pen-Based Technology in CAPI
- Multimedia Respondent Training
- Monitoring Personal Travel with Body-Pack Units
- Use of Personal Telephone Numbers for Travel Surveys

**Title: New Technologies for Household Travel Surveys**

**Pub:** Conference Proceedings 10 – Household Travel Surveys: New Concepts and Research Needs, 1996

**Auth:** Wayne Sarasua and Michael Meyer

**Abstract:** The advent of new technologies and recent advances in travel survey techniques have marked a new era in household travel surveys. Computer-assisted interviewing (CAI) technology has been available for more than 20 years; however, its widespread use in household travel surveys is a more recent trend. The reasons for this trend include advancements in personal computers, the introduction of graphical user interfaces, and the sophistication of CAI software. Some of today's CAI software includes built-in logic that can identify inconsistencies in a survey as it is being completed. Technologies designed specifically for use with spatially reference data (e, GIS and GPS) also benefit travel surveys. These technologies can result in more efficient data collection, improved data quality, reduced survey costs, and more flexible output products. this paper discusses current and potential uses of new technologies in household travel surveys. the advantages of these technologies are identified along with potential biases and errors that they may introduce into travel survey data. A discussion on possible research areas that focus on taking full advantage of new technologies is also presented.

**Title: Effects of Data Collection Methods in Travel and Activity Research**

**Pub:** European Institute of Retailing and Service Studies, 1996

**Auth:** D.F. Ettema , H. Timmermans, and L. van Vehl

**Abstract:** This research report contains the main findings of a study conducted to better understand the effects of the method of data collection on the validity and data quality of travel and activity data, where validity is described as the extent to which variables measure the concept they intend to measure and data quality is an indication of the completeness and distribution of the collected information. To this end, a literature search and interviews with experts have been conducted. This report is halfway between a literature review and a manual That is, to improve the accessibility of the text, a series of recommendations derived from the literature is made. Moreover, the report is supplemented with a subject index, that should help the reader to find specific options of data collection faster.

**Title: Effects of Different Data Collection Procedures in Time Use Research**

**Pub:** TRR 1493, 1995, pp. 110-117

**Auth:** Nelly Kalfs

**Abstract:** A field that might play an important role in the future of travel demand analysis and modeling is time use research, although some issues need to be resolved. One such issue deals with the data collection procedure. To provide guidelines to researchers, the strengths and weaknesses of three data collection systems are reviewed. One system relied on the traditional paper-and-pencil diary; another system was a self-administered electronic diary (computer assisted self-interview, or CASI), and the third was based on an interviewer-administered electronic procedure (computer-assisted telephone interview, or CATI). These systems are compared in terms of the validity of the time use statistics, the unit response rate, and time involved in conducting the survey. The results show that none of the data collection systems is best in all aspects: the unit response rate is highest in CATI, and the time to conduct the survey is lowest in CASI. As far as the validity is concerned, one method was not found to be best for all activities. the comparison clearly shows that relatively large differences exist among the procedures. consequently one must be careful using the results of studies that are based on different data collection systems. One specific activity that is of increasing interest to policy makers, that is travel, is illustrated.

**Title: The Implications of Emerging Contexts for Travel Behaviour Research**

**Pub:** Understanding Travel Behaviour in an Era of Change, Pergamon-Elsevier, Oxford, 1995, pp. 1-28

**Auth:** Martin Lee-Gosselin and Eric I. Pas

**Abstract:** This chapter examines major international trends that will have a determining impact on the future of travel-behaviour research, namely the emerging environmental, socioeconomic/demographic, and technological contexts. The implication of these contexts at both individual and societal levels are discussed with particular reference to the finding presented at the 1991 Quebec conference, including the other papers in this book. the future of travel-behaviour research is expected to be radically different from what has taken place in the previous three decades, partly because these emerging contexts compel researchers to adopt new paradigms for behavioural research, and partly because of major developments in the tools available.

**Title: The Design of Environmentally Aware Travel Diaries**

**Pub:** Transportation Planning and Technology, Vol 19, 1996, pp. 275-290

**Auth:** K.W. Axhausen

**Abstract:** Any policy addressing the concerns and trends associated with the impact of travel on the environment should be based on a solid understanding of the activities giving rise to them. While the measurement of the total environment loads by air or noise measurement stations is essential, it needs to be matched by the observation of the human behaviours creating them. This is especially true in the transport sector, which has been rightly or wrongly identified as having the potential to make a substantial contribution to the reduction of air and noise pollution... In the past transport planners have largely relied on the travel diary as their prime instrument to measure traveler behaviour. The travel diary is a survey instrument designed to record all movements during the course of one or more days including their relevant details. It is complemented by separate household and personal forms for recording general information. In the following paper the term travel diary implies all three elements (the diary, the person form, and the household form.) ...The remainder of the paper discusses to what extent and how the travel diary can be used to capture data for the assessment of policies directed at reducing the impact of transport on the social and natural environment. The requirements of a travel diary and the potential uses of new technologies in realising such a travel diary are then presented.

**Title: Measurement, Models, and Methods: Recent Applications**

**Pub:** Understanding Travel Behaviour in an Era of Change, Pergamon-Elsevier, Oxford, 1995, pp. 413-435

**Auth:** Peter Stopher

**Abstract:** This chapter examines five areas of applications of travel-behaviour models and methods, in terms of recent developments and new directions for applications. The five primary areas covered are:

- Data and survey methodology
- Exogenous inputs
- Extensions beyond mode choice
- Transferability in applications
- Non-traditional areas of application

This chapter does not attempt to summarize all applications work that has been undertaken around the world in the past three or four years, but rather attempts to highlight a number of interesting and important areas of applications. It is intended that some of these highlights will provide context to the papers that follow and will also knit together some useful application areas that may assist future applications.

**Title: Daily Variation of Trip Chaining, Scheduling, and Path Selection Behaviour of Work Commuters**

**Pub:** Understanding Travel Behaviour in an Era of Change, Pergamon-Elsevier, Oxford, 1995, pp. 351-379

**Auth:** Hani S. Mahmassani, S. Gregory Hatcher, and Christopher G. Caplice

**Abstract:** This study addresses the day-to-day variation of three key aspects of the home-to-work commute: (1) the time of departure from home, (2) the frequency, purpose, and duration of intervening stops between home and work, and (3) the path actually followed through the network. It is based on detailed two-week diaries of actual commuting trips completed by a sample of auto commuters in Austin, Texas. The paper examines alternative definitions and measures of variability in the context of the daily commute comparing a "day-to-day" approach to a "deviation-from-usual" approach for defining individual switching behaviour. Models are developed to relate observed trip-chaining, route, and departure-time switching patterns to the commuters' characteristics, such as workplace conditions, socioeconomic attributes, and network-performance characteristics. In addition, this study provides valuable confirmation of insights previously suggested in stated-preference laboratory experiments involving actual commuters in a simulated traffic system. About 25% of all reported commutes contained at least one non-work stop, underscoring the importance of trip-linking in commuting behaviour. These multipurpose trips are shown to influence significantly the departure time and route-switching behaviour of commuters. In general, commuters change departure time more frequently than routes, confirming previous results from laboratory experiments.

**Title: Evolution vs. Revolution in Computer-Assisted Surveys: Trends and Issues Concerning the Next Generation of CASIC Technology**

**Pub:** Presented at the 1994 Annual Research Conference and CASIC Technologies Interchange

**Auth:** J. Merrill Shanks

**Abstract:** This paper provides one perspective on the issues and challenges involved in the continuing development of systems for computer-assisted interviewing (CAI) and related aspects of survey data collection, management, and documentation. That perspective has been heavily influenced by the recent history and future plans of one such system, the Computer-assisted Survey Execution System (CASES), which has been developed by the University of California in cooperation with a substantial number of other survey-related organizations... A recurrent theme throughout the paper concerns the choices made by software developers between incremental (or evolutionary) development and comprehensive (if not revolutionary) redesign, and the impact of those choices on "production" survey organizations.

**Title: Workshop Summaries: Survey Methods in Transport, 3<sup>rd</sup> Intl Conference, 1990**

**Pub:** Selected Readings in Transport Survey Methodology, Eucalyptus Press, Melbourne, 1992  
from 3rd International Conference on Survey Methods in Transportation

**Auth:** Editors: Elizabeth S. Ampt, Anthony J. Richardson, and Arnim H. Meyburg

**Abstract:** Summaries include: New Technologies in Surveys, Weighting, Diary Surveys, and Stated Preference Surveys

**Title: Driver Exposure Survey Using Car Diaries**

**Pub:** Selected Readings in Transport Survey Methodology, Eucalyptus Press, Melbourne, 1992, pp. 175-189  
from 3rd International Conference on Survey Methods in Transportation

**Auth:** Helene Fontaine

**Abstract:** The search for high risk groups requires the computation of accident data and risk exposure data, often expressed as kilometres travelled. The aim of this paper is to analyse, from a car diary survey, driver's behaviour with regard to distance covered and driving speed, in order to get basic data for accident risk assessment. The survey was carried out by INSEE (Institut National de la Statistique et des Etudes Economiques) in 1981-1982. A car diary was provided for 2615 cars, and the driver(s) had to fill it in during a week. He (she) noted the characteristics of each trip (reason, hour, length, features of the driver and the passengers, etc). We first present the survey methodology, then we describe the data analysis method used in order to establish a typology of driver's exposure to risk.

**Title: Travel Surveys: Current Options**

**Pub:** TRR 1097, 1986, pp. 1-3

**Auth:** Emily Braswell Peterson and John R. Hamburg

**Abstract:** The underlying factors that form the basis for travel survey design and their relationship to the most common options currently available for collecting travel data are described. A comparison of the advantages and disadvantages of each of the options is also included.

**Title: Workshop Summaries: New Survey Methods in Transport, 2<sup>nd</sup> Intl Conference, 1983**

**Pub:** New Survey Methods in Transport, VNU Science Press, Utrecht, 1985, pp. 19-46  
from 2nd International Conference on Survey Methods in Transport

**Auth:** Editors: Elizabeth S. Ampt, Anthony J. Richardson, and Werner Brög

**Abstract:** The summaries copied include: Total Design Concepts, Sample Design, Questionnaire Design and Piloting, Response Errors and Data Correction, Survey Needs for Modelling, Perceptual Studies, Diary Surveys, and Interactive and Other Survey Methods

**Stated Preference Surveys**

**Title: Scope and Potential of Interactive Stated Response Data Collection Methods**

**Pub:** Conference Proceedings 10 – Household Travel Surveys: New Concepts and Research Needs, 1996

**Auth:** Martin Lee-Gosselin

**Abstract:** The scope of the growing number of interactive data collection methods directed at transport use response in future situations is reviewed. A brief introduction is given to the application of these methods under both the utility-maximization framework and a series of alternative assumptions about travel choice proposed by Gärling. It is suggested that the term most used in this domain of transport surveys, stated preference (SP), should be reserved for a particular subset of a diverse body of techniques that deserve a new nomenclature under the general term stated response (SR). A taxonomy of four classes of SR approaches according to where constraints or behavioral outcomes (or both) are predefined rather than elicited in the survey designs is presented. In view of the considerable existing literature on conventional SP, the discussion focuses mostly on the other SR approaches. Examples of these approaches are given from travel survey research, as well as some broad guidelines for the selection of techniques and some directions for further research.

**Title: The Safety Benefits of Restraints on Car-Use, Part I: Theoretical and Data Considerations for the Study of Behavior Mechanisms**

**Pub:** Draft, 1997

**Auth:** Martin Lee-Gosselin

**Abstract:** This paper reports on the data specification stage of a project to understand the behavioural mechanisms involved in changing the exposure of car drivers to accident risk over the longer term. The focus of this work is the adaptation of car-use in the face of external restraints, most of which are not conceived as accident-reduction measures; it also explores the extent to which drivers consciously take perceived accident risk into account when deciding how

much use to make of cars. This paper summarises a review and classification of recent interactive survey methods which may be used to explore the behavioural mechanisms. A brief history of related disaggregate exposure data collection is also given, together with a conceptual framework for studying the modification of travel patterns.

**Title: Using Stated-Preference Methods to Examine Traveller Preferences and Responses**

**Pub:** Understanding Travel Behaviour in an Era of Change, Pergamon-Elsevier, Oxford, 1995, pp. 177-207

**Auth:** John Polak and Peter Jones

**Abstract:** The objectives of this chapter are to provide a brief historical perspective on the development of SP methods, to discuss some important recent developments in both the application and methodology of SP studies, and to highlight some key research directions for the future. Our emphasis throughout is on general methodological issues rather than detailed technical matters. More detailed discussions of technical questions can be found in the references.

**Title: Design of Stated Preference Experiments**

**Pub:** MIT Shortcourse on Choice Modeling 1996

**Auth:** Jordan Louviere

**Title: Stated Preference Survey for Calculating Values of Time of Road Freight Transport in France**

**Pub:** TRR 1477, 1995, pp. 1-6

**Auth:** Laura Wynter

**Abstract:** A survey based on a stated preference experiment aimed at obtaining information about road freight transport subsequently useful in evaluating freight transporters' critical values of time is presented. The initial hypothesis in designing the survey was that values of time may vary significantly across the population; the experiment was thus designed so as to permit the evaluation of these critical values for each individual, as well as the identification of possible dependencies of the values on other trip attributes. The scope and methodology of the survey as well as an overview of the results are presented.

**Title: Employee Attitudes and Stated Preferences Toward Telecommuting: An Exploratory Analysis**

**Pub:** TRR 1413, 1993, pp. 31-41

**Auth:** Hani Mahmassani, Jin-Ru Yen, Robert Herman, and Mark Sullivan

**Abstract:** The potential effectiveness of telecommuting as a demand management strategy depends on the extent to which it is adopted by firms and accepted by employees. To gain insight into the factors likely to influence the adoption process, a survey of employees was conducted in three Texas cities: Austin, Dallas, and Houston. In this paper the survey results, focusing on the attitudes toward telecommuting held by employees who presently do not telecommute as well as on their stated preferences toward different telecommuting options are analyzed. Individual and job-related characteristics likely to influence employee participation in telecommuting programs are identified. The results suggest that successful programs are likely to require some job redesign and means of fair performance evaluation. In addition, success appears to depend on the economic arrangements involved, as most employees seem reluctant to trade income for the flexibility afforded by working from home.

**Title: Towards Electric Propulsion**

**Pub:** Chapter 3, "Toward Electric Propulsion" from the book Future Drive: Electric Vehicles and Sustainable Transportation, 1995, pp. 36-64

**Auth:** Dan Sperling

**Abstract:** It is no surprise that today's electric vehicles cost more and perform worse than their gasoline counterparts. Gasoline cars have benefited from a century of intensive development; electric cars have been virtually ignored for over seventy years. This chapter presents an overview of the history of the electric vehicle, obstacles to its successful integration in the US vehicle fleet, and the results of stated preference research in the area of electric vehicle acceptance in two or more vehicle households.

**Title: Demand for Clean-Fuel Vehicles in CA: A Discrete-Choice Stated Preference Pilot Project**

**Pub:** Transportation Research - A, Vol 27A, No. 3, 1993, pp. 237-253

**Auth:** David Bunch, Mark Bradley, Thomas Golob, Ryuichi Kitamura, and Gareth Occhiuzzo

**Abstract:** A study was conducted to determine how demand for clean-fuel vehicles and their fuels is likely to vary as a function of attributes that distinguish these vehicles from conventional gasoline vehicles. For the purposes of the study, clean-fuel vehicles are defined to encompass both electric vehicles and unspecified (methanol, ethanol, compressed natural gas or propane)liquid and gaseous fuel vehicles, in both dedicated or multiple-fuel versions. The attributes include vehicle purchase price, fuel operating cost, vehicle range between refueling, availability of fuel, dedicated versus multiple-fuel capability and the level of reduction in emissions (compared to current vehicles). In a mail-back stated preference survey, approximately 700 respondents in the CA South Coast Air Basin gave their choices among sets of hypothetical future vehicles, as well as their choices between alternative fuel versus gasoline for hypothetical multiple-fuel vehicles. Estimates of attribute importance and segment differences are made using discrete-choice nested multinomial logit models for vehicle choice and binomial logit models for fuel choice. These estimates can be used to modify present vehicle-type choice and utilization models to accommodate clean-fuel vehicles; they can also be used to evaluate scenarios for alternative clean-fuel vehicle and fuel supply configurations. Results indicate that range between refueling is an important attribute, particularly if range for an alternative fuel is substantially less than for gasoline. For fuel choice, the most important attributes are range and fuel cost, but the predicted probability of choosing alternative fuel is also affected by emissions levels, which can compensate for differences in fuel prices.

**Title: Forecasting Issues in Stated Preference Survey Research**

**Pub:** Paper for the 3rd International Conference on Survey Methods in Transportation, January 1990

**Auth:** M.A. Bradley and E.P. Kroes, Hague Consulting Group

**Abstract:** The family of market research survey techniques termed stated preference methods (e.g. conjoint analysis) has been used quite often in transportation planning over the past decade. While these techniques have been primarily used to gather marketing information, such as willingness to pay for service improvements, an important recent trend is the use of stated preferences in forecasting. Such methods are now becoming seen as a complement to the more traditional revealed preference survey methods in cases where the latter cannot provide the full information necessary... The need to accurately predict travel behaviour across the entire population places special requirements on the design, analysis, and application of stated preference survey experiments. Many of these requirements are analogous to those faced in revealed preference studies. There remain important issues specific to stated preference, however, because forecasting requires that a stated preference survey be built upon a hypothetical choice context which will yield realistic and unbiased statements of behaviour. As these issues are addressed, stated preference techniques appear to be evolving into an integrated part of the transport forecasting methodology. The purpose of this paper is to give an overview of this evolution, in terms of the study design, model estimation and forecasting issues involved. The discussion includes a treatment of the various errors and biases which may arise in stated preference as opposed to revealed preference surveys, along with reference to practical examples based on recent projects in the Netherlands, Australia, France, UK.

**Title: Attitudinal Analysis of Work/School Travel**

**Pub:** Transportation Science, Vol 15, No 3, August 1981, pp. 233-254

**Auth:** Frank Koppelman and Patricia Lyon

**Abstract:** This report describes the analysis of the choice of travel mode for trips to work or school through the study of attitudinal and behavioral responses. Travel behavior (mode choice) is linked to attitudes about the alternative modes through an intermediate preference construct. Individual attitudes are analyzed to obtain measures of perceptions of and feelings toward available transportation modes. These measures are related to mode preference, and preferences and situational constraints are related to choice. Differences in the perception-feelings-preference-choice formulation between travelers making local work trips and those making suburb-to-CBD work trips are identified and interpreted. The paper identifies (1) similarities and differences in the way perceptions are formulated and used to evaluate travel alternatives for local and suburb-to-CBD commuter trips and (2) the importance of including feelings measures in models of travel mode preference and choice.

## BOOK 3

### Selected Travel Surveys and/or Studies

**Title: Using Global Positioning Systems for Measuring Household Travel in Private Vehicles**

**Pub:** Conference Proceedings from the GIS-T Symposium, March 1997, pp. 38-48.

**Auth:** Elaine Murakami and David Wagner

**Abstract:** Preliminary report on field test results reported as reported in papers above and below.

**Title: Global Positioning Systems for Personal Travel Surveys**

**Pub:** Paper presented at National Traffic Data Acquisition Conference, May 1996

**Auth:** Elaine Murakami, David Wagner, and David Neumeister

**Abstract:** Preliminary report on test objectives and design as reported in papers above.

**Title: Survey Documents: 1996 GPS for Personal Travel Surveys**

**Auth:** FHWA and Battelle

**Note:** This includes all survey documents related to the Lexington FHWA project

**Title: FHWA Study Tour for National Travel Surveys**

**Pub:** September 1994

**Auth:** McElhane, Pisarski, Tweedie, Jarema, Fulton, Purvis, and TTEC

**Abstract:** In October 1993, a team of Federal, State, and local officials visited major centers in Europe where substantial national travel survey activities have been undertaken. Among the purposes of the visits were to seek out innovative methodological approaches to transportation survey design and operation, to review European experiences with different kinds of institutional arrangements, and to investigate new ideas in survey content and new collection methods. The countries visited included the UK, Denmark, the Netherlands, Sweden, France, and Germany. Information obtained in these visits will have direct and immediate application in the US (for the 1995 Nationwide Personal Transportation Survey). While the primary benefits of the field visits of the Travel Survey Panel will be the detailed evaluation of survey design and operations experience and in the wealth of supporting materials obtained... there are valuable broader perspectives that were obtained and can be identified... they are divided into the three discussion areas employed in the visits: institutions, content, and methods.

**Title: 1990 Household Travel Study: Final Report (Atlanta)**

**Pub:** December 1993

**Auth:** Atlanta Regional Commission

**Title: Survey: Alternative Fuels and Vehicles**

**Auth:** UCI / ITS: 1991

**Title: Survey: 1991 Statewide Travel Survey**

**Auth:** Caltrans

**Title: Survey: 1980 Bay Area Transportation Study**

**Auth:** Metropolitan Transportation Commission

## **Emissions, Travel Diaries, Gasoline, Dynamometers, Batteries**

**Title:** Using Travel Diary Data to Estimate the Emissions Impacts of Transportation Strategies: The Puget Sound Telecommuting Demonstration Project

**Pub:** Journal of the A&WMA, Vol 46, 1 Jan 1996, pp. 47-57

**Auth:** Dennis K. Henderson, Brett E. Koenig, and Patricia L. Mokhtarian

**Title:** Estimating Impacts of Transportation Control Measures on Work-Related Trips

**Pub:** TRR 1518, 1996, pp.32-37

**Auth:** Daivamani Sivasailam and Jon Williams

**Title:** Functional Form Analysis of the Short-run Demand for Travel and Gasoline by One-Vehicle Households

**Pub:** TRR 1092, 1986, pp. 10-15

**Auth:** David L. Greene and Patricia S. Hu

**Title:** Influence of the Price of Gasoline on Vehicle Use in Multivehicle Households

**Pub:** TRR 988, 1984, pp. 19-24

**Auth:** David L. Greene and Patricia S. Hu

**Title:** Passenger Car Testing: Acceleration Measurement on Dynamometer and Road

**Pub:** Intl Journal of Vehicle Design, Vol 5 no 5, Sep 1984, pp. 585-598

**Auth:** K.J. Rogers and R. R. M. Johnston

**Title: Battery Reference Book**

**Pub:** Butterworth & Co., 1990

**Auth:** T R Crompton

**Abstract:** This book attempts to draw together in one place the available information on all types of battery now being commercially produced. Sections of the book include:

Introduction to battery technology

Battery performance evaluation

Guidelines to battery selection

Battery applications

Battery characteristics

Battery charging

Battery theory and design

Battery suppliers

**Title: Handbook of Batteries**

**Pub:** McGraw-Hill, Inc., 1995

**Auth:** David Linden, Editor in Chief

**Abstract:** This Handbook is intended to thoroughly cover all batteries and battery technology, with the emphasis on providing detailed up-to-date information on the advantages/disadvantages, characteristics, properties, and performance of all types of electric batteries and fuel cells. The book is organized as such:

Principals of Operation

Secondary Batteries

Primary Batteries

Advanced Battery Systems

Reserve Batteries

## BOOK 4

### Instrumented Vehicle Studies

**Title: Austin 1997-1998 Transportation Household Travel Survey (PAPI) with GPS Equipment**

**Pub:** Project Update, June 1998 and Technical Memorandum, August 1997

**Auth:** Trey Gamble and David Pearson (TTI)

**Title: Determining Heavy Duty Truck Activity Using GPS Technology**

**Pub:** Presented at the 8<sup>th</sup> CRC On-Road Vehicle Emissions Workshop, April 1998

**Auth:** David Wagner, John Seymour, Norman Malcosky, John Kinateder, John Nguyen

**Abstract:** CARB and FHWA have joined with Battelle in conducting a study of medium- and heavy-duty trucks being used in the transport of goods and services. This two-year program uses satellite positioning (GPS) technology to characterize the activity in five weight classes of trucks. Specifically, information is being collected on the average number of starts per day, average speed per trip, average duration at idle per trip, and percentage of time at various speeds by regions of the state. This data was previously obtained by roadside-driver surveys and was of questionable accuracy or using trip recorders that are much more intrusive. The information will be used by these agencies in improvement of their respective vehicle emissions inventory models (which are used in predictions of air quality) and to better understand congestion/route patterns. Since the California truck population is in excess of 430,000 vehicles, obtaining a representative sample of the various trucks is a problem. A sampling plan has been developed that follows our current understanding of the truck population, vehicle configuration, and various air-basins within California. The plan maximizes our ability to make comparisons across regions within the state, given the limited numbers of vehicles that can be sampled. This paper reports on the success of this sampling method for truck activities and describes results from analyzing data sets that have been obtained to date. Processing and combining these data sets with GIS highway maps has allowed a graphical description of how the trucks are used within each CA air district. Additional trucking firms are currently being recruited into the program to provide the range of vehicle uses needed to populate the sampling plan.

**Title: Using GPS/GIS for the Collection of Motor Vehicle Activity Data**

**Pub:** Presented at the Environmental Management and Technology Conference, Nov 1997.

**Auth:** Michael Benjamin (CARB)

**Abstract:** Collection of spatially-resolved motor vehicle activity is critical to the accurate spatial allocation of motor vehicle emissions, as well as accurate transportation models, necessary for the development of effective environmental regulations. The term 'motor vehicle activity' includes such parameters as number of trips per day, vehicle speed as a function of roadway type, and trip purpose. Until recently, motor vehicle activity data have been collected using techniques such as embedded roadway speed sensors or written and telephone surveys. However, these methods of activity data collection may be limited in their applicability or subject to bias. The recent development of low-cost, accurate GPS receivers, in conjunction with improvements in GIS software and digital databases, may provide a more accurate method for the collection of motor vehicle activity data.

**Title: GPS Antenna Placement Analysis in an Automobile Simulation and Performance Test Results**

**Pub:** Presented at the 1997 Intelligent Transportation Symposium in Washington, D.C.

**Auth:** J. Blake Bullock, Motorola Corporation

**Abstract:** GPS receivers are used extensively in ITS for positioning and navigation. Positions derived from GPS receivers are the key pieces of information in emergency location systems, theft recovery systems, vehicle tracking systems, and in-vehicle navigation systems. GPS receivers use L-band signals from orbiting satellites to compute the three-dimensional (3D) position and the velocity vector components of the vehicle platform. The signals are line-of-sight and are blocked by metal and other materials, so proper antenna placement on a vehicle is critical for optimum

performance. GPS antennas are relatively small, so there are many possible locations for mounting them on a vehicle. In some cases, multiple antennas may be required for added safety and security. The trend for vehicle mounted GPS antennas is to mount them in discreet or hidden locations to prevent detection and/or theft. Ease of installation and servicing is also an important consideration when selecting a location for the GPS antenna to be installed. This paper investigates the performance implications of mounting GPS antennas in the passenger compartment of a vehicle. The reduced coverage due to reduced satellite visibility is evaluated. The benefit of a dual antenna system is considered. The effect of antenna placement on dilution of precision (DOP) measures and satellite availability is analyzed. The analysis is based on simulated satellite alert data and actual road test data recorded in both forested and urban canyon areas. The results of the analysis show that mounting the GPS antenna on or under the front dashboard or on or under the rear package shelf has minimal impact on the overall availability and accuracy of GPS positions. For both locations the angle of the glass is the most significant factor in the performance. There is little or no benefit from having antennas mounted in both locations.

**Title: Vehicle Uses and Operating Conditions: On-Board Measurements**

**Pub:** Understanding Travel Behaviour in an Era of Change, Pergamon-Elsevier, Oxford, 1995, pp. 469-481

**Auth:** Michel André

**Abstract:** A large-scale experiment has been carried out by INRETS to identify actual vehicle-use conditions. Fifty-five privately-owned cars were equipped with sensors and data-acquisition systems and studied under actual use conditions with their own drivers. Vehicle and engine speeds, engine and ambient temperatures, and fuel consumption were recorded at one-second time intervals over 71,000 kilometres and 9900 trips. The data obtained yielded very accurate information on the actual car use and operating conditions: daily vehicle use, trip characteristics (trip length, duration, and so on), speed and acceleration profiles, engine running conditions (engine speeds, choke use, etc.), and thermal conditions, while taking into account the influence of vehicle type, driver behaviour and geographical location. Vehicle uses were very frequent (5 to 6 trips per day) and often short: one trip in two did not exceed three kilometres. time spent at rest or at low speed was very significant. The uses were highly diversified according to the drivers and the areas of origin of the vehicles studied. The results are compared to those obtained during a driving diary survey conducted by INRETS. Significant discrepancies are to be observed concerning trip lengths and vehicle-use frequencies. The INRETS on-board measurement method is described, including its specificity, its advantages, and its limits.

**Title: Analysis of Travel Behavior using Three-Parameter Dataloggers**

**Pub:** Journal of Transportation Engineering, Vol 121, No. 4, 1994, pp. 338-344

**Auth:** Catherine L. Ross, Michael D. Meyer, Scott Barker, and Yared Zemere

**Abstract:** Dataloggers were used in Atlanta to measure vehicle velocity, engine revolutions per minute, and manifold absolute pressure on 77 vehicles. The in-vehicle dataloggers measured the characteristics of over 4600 trips generated by these drivers. The resulting database provides a rich source of information on travel patterns, trip speed, trip duration, and maximum velocity. The use of dataloggers that actually measure engine performance presents a unique opportunity to infer travel behavior from a non-traditional source. In a sample application, the database was refined and analyzed to measure urban and suburban trip-chaining behavior. While this application is for a small number of travelers, it is useful in demonstrating the benefits of recording travel behavior through the use of dataloggers. The findings outline the potential of this method in investigating travel behavior in urban areas. Many of the findings of the sample application are consistent with expectations, with the notable exception of urban chained trips, which generally had longer trip durations than suburban chained trips.

**Title: Current Hybrid Electric Vehicle Performance Based on Temporal Data from the World's Largest HEV Fleet**

**Pub:** <http://www.hev.doe.gov/papers/evspap.html> (1994)

**Auth:** K. Wipke

**Abstract:** The U.S. Department of Energy (DOE) procured new data collection equipment for the 42 vehicles registered to compete in the 1994 Hybrid Electric Vehicle (HEV) Challenge, increasing the amount of information gathered from the world's largest fleet of HEV's. Data were collected through an on-board data storage device and then analyzed to determine effects of different hybrid control strategies on energy efficiency and driving performance. In this paper, the results of parallel hybrids with respect to energy usage and acceleration performance are examined, and the efficiency and performance of the power-assist types are compared to that of the range-extender types. Because on-board and off-board electrical charging performance is critical to an efficient vehicle energy usage cycle, charging performance is presented and changes and improvements from the 1993 HEV Challenge are discussed. Peak power used during

acceleration is presented and then compared to the electric motor manufacturer ratings. Improvements in data acquisition methods for the 1995 HEV Challenge are recommended.

**Title: Global Positioning Systems in the Time Domain: How Useful a Tool for IVHS?**

**Pub:** Transportation Research C, Vol. 3, No. 4, pp. 193-209, 1995

**Auth:** R. Zito, G. D'Este, and M.A.P. Taylor

**Abstract:** Much of the research and development work in intelligent vehicle-highway systems (IVHS) relies on the availability of methods for locating and monitoring vehicles (e.g. "probe vehicles") in real time across a road network. This paper considers the use of the global positioning system (GPS) as one method for obtaining information on the position, speed and direction of travel of vehicles. It reports the results of a series of field studies, in which real-time GPS data were compared to data collected by an instrumented vehicle, under a range of physical and traffic conditions. The field studies and consequent data analysis provide a picture of the reliability and usefulness of GPS data for traffic monitoring purposes, and hence the possibilities for the use of GPS in IVHS projects. The use of GPS receivers tailored for mobile applications, and able to provide direct observations of vehicle speed and travel direction, coupled with database management using geographic information systems (GIS) software, was found to provide a reliable and efficient system for vehicle monitoring. Field data collection under "ideal" GPS conditions indicated that accurate speed and position data were readily obtained from the GPS. Under less favorable conditions (e.g., in downtown networks), data accuracy decreased but useful information could still be obtained. In addition, the conditions and situations under which GPS data errors could be expected were noted. The finding that it is possible to relate standard GPS signal quality indicators to increased errors in speed and position provides an enhanced degree of confidence in the use of the GPS system for real-time traffic observations.

**Title: The Use of GPS in Travel-Time Surveys**

**Pub:** Traffic Engineering and Control, Vol 35, 12 Dec 1994, pp. 685-690

**Auth:** Rocco Zito and Michael A. P. Taylor

**Abstract:** Travel-time surveys have long been used to provide performance data for the assessment of traffic systems. The traditional methods of finding the amount of travel time have been difficult to apply and sometimes provided only limited information. With the advent of GPS, a new era in transport data collection has arrived. Not only will it benefit data collection in travel-time surveys, but other areas dealing with transportation issues will also gain, e.g. road asset management, IVHS, and real-time vehicle tracking among others... The GPS-GIS combination forms an effective partnership in that the GPS system allows the efficient collection of data, while the GIS provides an interface that allows these data to be displayed together with their spatial attributes. Most GIS packages also perform queries on the database, with results thus being displayed graphically. Thus the combination provides a very powerful tool that can be used in the assessment of any transportation system.

**Title: TravTek Driver Information System**

**Pub:** IEEE-IEE Vehicle Navigation and Information Systems Conference Proceedings, 1993

**Auth:** Different authors for each report

**Abstract:** This report is actually five separate reports on various aspects of TravTek (short for Travel Technology), which is the operational field test of an advanced driver information and traffic management system tested on 100 cars from March 1992 through March 1993 in Orlando, FL. The separate reports are:

- TravTek Evaluation Overview and Recruitment Statistics
- Professed Willingness to Pay for Travtek Features
- A Preliminary Account of TravTek Route Guidance Use by Rental and Local Drivers
- Modeling Fuel Consumption and Vehicle Emissions for the TravTek System
- TravTek System Architecture Evaluation: Preliminary Analysis of selected Elements

**Title: An Instrumented Vehicle for Microscopic Monitoring of Driver Behaviour**

**Pub:** : IEEE-IEE Vehicle Navigation and Information Systems Conference Proceedings, 1993, pp. 401-404

**Auth:** M. Brackstone and M. McDonald

**Abstract:** A vehicle based data collection system has been explored which is capable of gathering accurate data on the relative movements of adjacent vehicles, and hence driver behavior, in a traffic stream. The instrumented vehicle may support a variety of detection devices, for example a tracking laser rangefinder head, or a constantly scanning laser beam (a LIDAR). To relate the measurements to the position of the vehicles on the road, several sub-systems have been

devised to calculate corrections required by variations in steering, and vibrational movements caused by the road surface. Operational specifications of the vehicle have been devised, in terms of road and traffic conditions required for optimum performance, and strategies put forward for use.

**Title: Light-Duty Vehicle Driving Behavior: Private Vehicle Instrumentation**

**Pub:** Four Reports by Radian Corporation, Austin, TX, 1992

**Auth:** T. H. DeFries and S. Kishan

**Abstract:** This set of four bound reports reviews the techniques and preliminary results obtained from a private vehicle instrumentation study conducted by Radian under the direction of the EPA, Certification Division of OMS. The four reports include:

- Volume 1: Technical Report
- Volume 2: Speed and Acceleration Measures
- Volume 3: Trip Measures
- Volume 4: Vehicle Driver Measures

In February and March of 1992, 293 privately owned light-duty vehicles were instrumented in Spokane, WA and Baltimore, MD. The instrumentation remained on each vehicle for a one-week period. Vehicle speed, engine RPM, and manifold absolute pressure data were collected on these vehicles for every second that the engine was on. Following the implementation of strict data quality checking procedures, a database was created obtaining the one-week's worth of data from 216 of the vehicles. This database contained information on 12,073 trips and 6,940,411 seconds of vehicle and engine operating data.

**Title: AUTOLOGGER: A Long Duration Vehicle Use Data Collection System**

**Pub:** Conference Proceedings: Sixth International Conference on Travel Behaviour, May 1991, Vol 2, pp. 432-443

**Auth:** Gordon W.R. Taylor

**Abstract:** One of the basic needs for road system planning and impact analysis is accurate and detailed data on usage of vehicles. The availability of data on the usage profile of vehicles has historically been of poor quality and expensive to collect. Typically, travel surveys were used in the form of recall, road side or diary surveys. These techniques, while capable of creating general information on the number of trips, distance and average speeds, etc, can not provide data which is required to fully assess emission, energy or other instantaneous impacts of driving. At best, the current methods produce a snap shot usage or longitudinal data over short time periods. The author has developed a survey system which is capable of measuring instantaneous speeds and thus improving on the level of data detail. The system has the advantage of being able to provide continuous information on vehicle usage over extended periods of time. This allows for accurate measurement of the changes in travel demand with changes in lifestyle, fuel and road pricing and other economic conditions. The Autologger hardware has been purposely designed for large scale survey applications and thus is easy and fast to install, the data is retrievable on a mailable data card, and it is modestly priced. The system, once installed is passive to the user until they are asked to replace the data card and send the old one back to the surveyor. Further, the analytical program is contained on the data card and thus can be modified by the researcher over time. The paper discusses the system hardware, analytical techniques, and presents typical outputs. Examples of the application of the survey technique is also provided.

## **Other Transportation-Related Technology Applications**

### **Title: Applications of GPS for Surveying and Other Positioning Needs in DOTs**

**Pub:** NCHRP Synthesis 258, TRB, 1998

**Auth:** Robert J. Czerniak and James P. Reilly

**Summary:** ...The need for more accurate and cost-effective data-gathering techniques, as well as the increasing demand for spatial data, require that state DOTs use the latest and best technology available to measure and locate facilities. One technology that makes these tasks easier, cheaper, and more accurate is the GPS...Since the early 1990s DOTs across the nation, as well as other federal and state agencies, universities, and private companies have tested the technology in a variety of ways. Some examples include establishing survey baselines, increasing accuracy of traditional survey methods, control densification, project control, and mapping control...In addition, some innovative applications have also been attempted, such as vehicle location and identification, tracking buses, assisting in photogrammetry, emergency response, and photo logging of highways with a GPS assist. Other applications of GPS that state DOTs can find effective include using GPS differential positioning to locate, track, and navigate vehicles... It is clear that GPS is not only a new technology, but a new way of locating features on the earth's surface and making earth-based measurements. It provides labor savings, increases positional accuracy, and is applicable to a wide range of modal needs. GPS supports the work of surveyors, civil engineers, planners, geographers, GIS technicians, and staff working in environmental studies.

### **Title: Applications of GIS Technology in Recent Household Travel Surveys**

**Pub:** Conference Proceedings from the GIS-T Symposium, March 1997, pp. 95-133

**Auth:** Stephen Greaves

**Abstract:** Changes in travel survey design and the utilization of modern technological capabilities have marked a new era in household travel and other surveys conducted as part of the metropolitan transportation planning process. One technology that intuitively offers great potential to improve the actual planning and interpretation of such surveys is GIS technology. This report draws on the experiences of more than forty metropolitan household travel surveys to determine how GIS capabilities have been used as part of such survey methodologies. Nearly half the surveys did not use GIS while the remainder have used various GIS capabilities to support segments of the travel survey process. The primary uses of GIS have been in the processing and analysis of data that has already been collected. This has resulted in greatly improved efficiency of survey operations, such as the geocoding and reformatting of data, and significant improvements in the quality of data. There has also been growing recognition of the potential benefits to the survey operation and the quality of data that could result from incorporating GIS capabilities into the design and implementation phases of the survey process. Some more innovative approaches are presented here. Also, included in this report are some critical issues to be addressed regarding the incorporation of GIS capabilities into the survey process. Finally, some recommendations are made for how these issues might be overcome in the design and conduct of future household survey efforts.

### **Title: GIS Applications to Household Activity and Travel Patterns**

**Pub:** TRR ??, updated 1995

**Auth:** Yuanjun Li and David Hartgen

**Abstract:** Household activities and their resulting travel patterns are the basis of urban transportation planning, but are not used directly in travel demand models. A new model is proposed that uses activity patterns directly in a GIS framework. The model plots the location of trips by zone in urban areas, then overlays these trips on regional street and demographic data. An ARC/Info environment operated on a Sun SPARC workstation, in conjunction with travel data from the Charlotte, NC area, is used. An "ellipse" pattern is used to define the buffer around each major trip within which other trips occur. It is found that for most simple chains, the ellipse defines the area for a third activity between two other higher-priority activities. This means that the buffer area for most decision models will be very small, and the choice set very limited. The next step is the development of a fully operational activity model using the GIS. The model is being developed for FHWA as part of an initiative to develop new methods of forecasting the impacts of non-traditional transportation policies in urban areas.

**Title: New Approach to Route Choice Data Collection: Multiphase, Computer-Aided Telephone Interview Panel Surveys Using Geographic Information Systems Data Base**

**Pub:** TRR 1493, 1995, pp.159-169

**Auth:** Mohamed A. Abdel-Aty, Ryuichi Kitamura, Paul P. Jovanis, Prasuna Reddy, and Kenneth M. Vaughn

**Abstract:** The survey approach is often used in studying drivers' route choice behavior. Surveys enable the researcher to analyze route choice behavior and the effects of traffic information directly from reported behavior and perceptions of the respondent. A sample that represents well the population in the study area could facilitate better understanding of actual drivers' behavior and decision processes. Three route choice surveys targeting a random sample of commuters in the Los Angeles area are presented. The first two surveys were 1 year apart, and the third survey was a follow-up mail questionnaire. The surveys involved two innovative techniques that achieve the data collection required for the analyses of route choice, traffic information acquisition, and commuters' potential use of advanced traveler information systems. The first technique is using computer-aided telephone interviews, and the second utilizes geographic information systems capabilities.

**Title: Use of GIS for Transportation Data Analysis**

**Pub:** Microcomputers in Transportation, 1993, pp. 94-102

**Auth:** Shirley Hsiao and James Sterling

**Abstract:** Origin-destination (O-D) survey data have been usually applied to identify travel characteristics for transportation planning activities. Travel forecasting models are also validated against O-D data to simulate more reliable trip estimations. The process of translating these survey data to final analysis format, is however, generally recognized as labor intensive and time consuming. This paper describes how GIS techniques were applied to analyze commuter rail survey data from which the upcoming inter-country rail service design can be projected and tailored. The use of a GIS enhances the accuracy and efficiency of O-D survey data analysis and also provides detailed spatial analysis results for transportation service evaluation.

**Title: Machine Vision-based Traffic Surveys**

**Pub:** Proceedings of SPIE, International Society of Optical Engineering, Vol 2592, 1995, pp.94-98

**Auth:** Salvatore D'Agostino

**Abstract:** Determination of vehicle origins and destinations, calculation of travel times and measurement of traffic congestion are the common goals of traffic surveys. In the last few years the use of machine vision has been able to increase the accuracy of these measurements, the turn around time of traffic surveys and improve the breadth and depth of the information that can be captured regarding these traffic flow parameters. This paper describes several surveys that have been conducted using machine vision, in both the US and Europe.

**Title: Speech Recognition -- A New Dimension in Survey Research**

**Pub:** Journal of the Market Research Society, Vol 36, Issue 3, July 1994, pp. 183-203

**Auth:** Bill Blyth and Heather Piper

**Abstract:** At a time when the cost of market research is of increasing concern, market researchers need radical, imaginative and innovative solutions to meet client needs. This paper is about such a solution - speech recognition. The paper is divided into four main sections. First it discusses the issues of productivity and quality in relation to existing data collection methods and the latent needs that exist. Secondly it describes the technology of speech recognition and how it works. Thirdly it describes how Taylor Nelson AGB in conjunction with GEC Marconi have established English speech databases which will provide the basis for modeling any word used in everyday speech. Lastly it describes the development of real market research applications using speech recognition. The reported work is the first part of a programme partially funded by the DTI. Further results will be published as they become available. We believe the paper demonstrates how technology can be applied in novel ways to move our profession forward.

**Title: Management of a Small Home Interview Travel Survey using a Microcomputer**

**Pub:** TRR 1134, 1987, pp. 49-56

**Auth:** Ronald Eash (CATS)

**Abstract:** In this paper, how a microcomputer and general-purpose business software were used in a small telephone survey of household travel behavior is discussed. Principal applications covered are (a) selecting sample households; (b) mailing to sample households; (c) scheduling interviews; (d) checking the status of each interview (e) developing the completed interview data sets; and (f) reporting survey results. Staffing requirements and expenditures to complete the survey are also presented. This form of computing is well suited to data collection projects of this size.

## Survey Bias and Response Rate Issues

### **Title: Motivating the Respondent: How Far Should You Go?**

**Pub:** Paper presented at IATBR, Sept 1997

**Auth:** Peter Bonsall

**Abstract:** Two separate but related issues are addressed; the use of incentives to improve response rates and the use of rewards and incentives to encourage 'realistic' responses in experiments. Important questions are raised which have implications for the reliability of data and yet which have been largely ignored in the design of surveys and experiments. The paper draws on evidence from recent surveys and experiments and on relevant behavioural theory and suggests that there is a fine line to be drawn between sufficient motivation and excessive incentivisation. It is clear that incentives can influence response rates, that individuals are influenced to a different degree by different forms and levels of incentive and that some are put off by them. It follows that, where participation is voluntary, the use of incentives may influence the results obtained, but it is not immediately apparent whether the incentivised or the unincentivised respondents will yield 'truer' data.

### **Title: Workload, Response Rate, and Data Yield: Experiments with Long-Distance Diaries**

**Pub:** Paper presented at TRB, January 1997

**Auth:** Kay Axhausen, H. Koll, M. Bader, and M. Herry

**Abstract:** Workload, response rate, data yield, and quality of travel diaries are interacting variables. It has long been suspected that it is impossible to maximize all variables at the same time. Still, empirical work trying to improve our understanding of the trade-offs between them has been very rare. This paper reports results from experiments with long-distance diaries, which aim to clarify some of the possible relationships. The object of experimentation are surveys of long-distance travel behaviour, which are currently of particular interest in Europe and elsewhere. The development of the tourism industry, deregulation of the long-distance modes and infrastructure concerns require improved data about long-distance travel, both in the sense of improved inventories as well as in the sense of improved behavioural understanding. The experiments undertaken here varied the workload of the respondents by varying the number of items to be reported about any long-distance journey, the duration of the survey period and the temporal orientation of the survey. The results indicate that the response rate and the data yield, i.e. the number of reported journeys and stages, change systematically with the changes in the experimental variables (reduced response rates for prospective surveys; reduced number of reported journeys and stages for retrospective surveys). Detailed results for these trade-offs are given in the paper. This trade-off forces the designer of such surveys to choose carefully and to invest time and effort in correcting for the potential biases resulting from this systematic behaviour.

### **Title: Nonresponse Issues in Household Travel Surveys**

**Pub:** Conference Proceedings10 – Household Travel Surveys: New Concepts and Research Needs, 1996

**Auth:** A.J. Richardson, E.S. Ampt, and A.H.Meyburg

**Abstract:** Sample surveys in transport are invariably associated with some level of nonresponse. The issue of nonresponse is fundamentally connected with the questions of reducing survey bias and increasing the accuracy of sample estimates. This is because nonrespondents are from segments of the population having characteristics significantly different from those of respondents. The differences are in sociodemographic characteristics, and, more important, in travel behavior characteristics. Some of the background concepts of transport surveys within which nonresponse should be considered are described. In particular, the distinction between sampling error and survey bias and the trade-offs between quantity, quality, and cost of survey data are described. Ways of reducing nonresponse and the impacts of nonresponse are discussed. The need to consider all sources of nonresponse in different types of survey and the importance of using consistent methods of calculating nonresponse are stressed. The use of population expansion factors, nonreporting weights, and nonresponse weights as ways of allowing for the remaining extent of nonresponse is described. The use of these methods is demonstrated by reference to a mailback questionnaire survey.

### **Title: Incentives and Rates of Returns for Travel Surveys**

**Pub:** TRR 1551, 1996, pp. 67-73.

**Auth:** Melissa Tooley

**Abstract:** In recent years, lower rates of return for household-based travel surveys have become a reality. It may be difficult to collect enough data for effective transportation planning. Various incentive methods have been used to

induce survey recipients to participate fully. Incentive methods will be described (along with other factors affecting rates of return), and their apparent effect on rates of return discussed. It appears that monetary incentives sent with survey materials are most effective in increasing return rates; nonmonetary incentives offered with survey packets are somewhat less effective. The data are inconclusive regarding monetary and nonmonetary incentives offered as a reward upon completion of surveys.

**Title: Asking Sensitive Questions: The Impact of Data Collection Mode, Question Format, and Question Context**

**Pub:** Public Opinion Quarterly, Vol 60, 1996, pp. 275-304

**Auth:** Roger Tourangeau and Tom Smith

**Abstract:** This study compared three methods of collecting survey data about sexual behaviors and other sensitive topics: computer-assisted personal interviewing (CAPI), computer-assisted self-administered interviewing (CASI), and audio computer-assisted self-administered interviewing (ACASI). Interviews were conducted with an area probability sample of more than 300 adults in Cook County, IL. The experiment also compared open and closed questions about the number of sex partners and varied the context in which the sex partner items were embedded. The three mode groups did not differ in response rates, but the mode of data collection did affect the level of reporting of sensitive behaviors: both forms of self-administration tended to reduce the disparity between men and women in the number of sex partners reported. Self-administration, especially via ACASI, also increased the proportion of respondents admitting that they had used illicit drugs. In addition, when the closed answer options emphasized the low end of the distribution, fewer sex partners were reported than when the options emphasized the high end of the distribution; responses to the open-ended versions of the sex partner items generally fell between responses to the two closed versions.

**Title: Do interviewers follow telephone survey instructions?**

**Pub:** Journal of the Market Research Society, Vol 38, No. 2, April 1996, pp. 161-176

**Auth:** Pamela Kiecker and James Nelson

**Abstract:** Misbehaviour by survey interviewers includes actions forbidden either explicitly or implicitly in codes of ethics, interviewer training, or interviewing instructions. As examples of misbehaviour, interviewers can reword questions, answer questions when interviewees refuse to respond, or fabricate answers to entire questionnaires. This study investigates the nature and incidence of such interviewer actions in telephone surveys, currently the most popular mode of data collection in marketing research in the US. It uses both a mail survey and field experiment with samples of survey interviewers to investigate four factors hypothesized to influence misbehaviour by interviewers. Results indicate that misbehaviour by telephone interviewers is ordinary and normal. Recommendations for reducing interviewer actions classified as misbehaviour are provided for research suppliers, marketing managers, and marketing academics.

**Title: Household Travel Survey Nonresponse Estimates: The Chicago Experience**

**Pub:** TRR 1493, July 1995, pp. 170-177

**Auth:** Ashish Sen, Siim Sööt, Lidan Yang, and Ed Christopher

**Abstract:** Because response rates vary by household type and by neighborhood, certain groups can be underrepresented. Factoring can rectify this situation somewhat for data used for descriptive purposes, but assumptions underlying many model estimation procedures are violated if factored data are used. Perhaps the only practical solution is to increase the sampling rate of underreporting groups. Because sampling rates should be proportional to reciprocals of response rates, a model to estimate response rates is presented. Such a model could be of value for implementing future surveys. A logit regression model was constructed with the demographic data as independent variables. Observations on the dependent variable, response rate, were obtained from a large scale household travel survey conducted in the Chicago metro area by CATS.

**Title: A Demographic Analysis of the Impact of Presurvey Letters on Cooperation Rates in Urban Neighborhoods**

**Pub:** Paper presented at the Annual Meeting of the Amer. Assoc. for Public Opinion Research, May 1994

**Auth:** Roger Parks, John Kennedy, and Laura Frye Hecht

**Abstract:** Recently survey researchers have been examining a variety of list-assisted techniques to improve cooperation rates in telephone surveys. Declining response rates along with the need to reduce costs have prompted researchers to search for alternatives or supplements to random-digit-dialing (RDD) surveys. In this paper, we present the results from

two surveys that used list-assisted randomly-selected telephone numbers. The surveys were conducted in 50 neighborhoods in Indianapolis during 1993. Our analysis focuses on two issues. First, we analyze the differences in cooperation rates between samples when presurvey letters were sent and when they were not sent. Second, we examine the demographic characteristics of the neighborhoods based on the 1990 decennial census to determine the impact of differential cooperation on the demographic representativeness of the samples. The cooperation rates in neighborhoods that received presurvey letters were higher than both an RDD sample and in neighborhoods that were not sent letters. There are mixed results from a comparison of the demographic characteristics of the neighborhoods and the demographic characteristics of the various samples. Overall, the presurvey letters did not yield samples that were closer to census proportions than those that did not receive letters.

**Title: Role of Special Mailings in Reducing the Potential for Bias in a Heterogeneous Population**

**Pub:** Social Science Quarterly, Vol 75, No. 1, March 1994, pp. 213-219

**Auth:** E. Lee Bernick and David Pratto

**Summary:** This research addresses the issue of whether or not special mailings are needed in order to reduce potential response bias in a heterogeneous population. The research finding support the efficacy of undertaking special efforts to obtain the responses of individuals who are members of heterogeneous populations. Those scholars who dismiss the necessity of using special mailings in order to save money do so at the risk of losing valuable insight into how a broader segment of the population thinks.

**Title: The Answering Machine Generation, Who Are They and What Problem Do They Pose for Survey Research?**

**Pub:** Public Opinion Quarterly, Vol 58, 1994, pp. 264-273

**Auth:** Robert Oldendick and Michael Link

**Abstract:** Increased incidence of telephone answering machines and the use of such devices to screen calls pose a potential threat to the representativeness of samples in telephone surveys. Using data from nine statewide surveys, this analysis examines the extent to which answering machines are used to screen calls and the demographic characteristics associated with answering machine use and call screening. Results show that at most two or three percent of households use answering machines to screen calls, and that such screening is more likely to take place in household with higher family incomes, outside rural areas, and which include individuals who are younger and have higher levels of education. While call screening does not presently threaten the representativeness of samples in telephone surveys, the increased incidence of answering machines together with the increased percentage of households indicating these devices are sometimes used to screen calls demonstrate that the potential bias from this source is growing.

**Title: Phoneless in America -- Statistical Brief from the Bureau of the Census**

**Pub:** SB/94-16, July 1994

**Auth:** US Dept of Commerce, Economics and Statistics Administration, Bureau of the Census

**Abstract:** You could have picked up a phone and called almost every American household in 1990, but not all of them. That's because there were nearly 5 million households (5 percent) without a phone. The phoneless tended to be in the South. Most often, the young were phoneless. Most of the phoneless were renters. Men living alone were likeliest to have no phone.

**Title: Temporal Stability of Travelers' Activity Choice and Home-Stay Duration: Some Empirical Evidence**

**Pub:** Transportation, Vol 21, 4 Dec 1994, pp. 371-392

**Auth:** Fred Mannering, Elaine Murakami, and Soon-Gwan Kim

**Abstract:** This paper explores the temporal stability of activity type-choice models and models of travelers' home-stay duration. To empirically evaluate this stability, a nested logit model of activity-type choice and a proportional hazards model of home-stay duration are estimated using data from two-day travel diaries collected in the fall of 1989 and again, from the same individuals, in the fall of 1990. The results show that the models are not temporally stable over the one year time period separating the two travel-diary samples. A number of possible reasons for this instability are discussed.

**Title: Cognitive Processes in Self-Report Responses: Test of Item Context Effects in Work Attitude Measures**

**Pub:** Journal of Applied Psychology, Vol 78, No 1, 1993, pp. 129-140

**Auth:** David Harrison and Mary McLaughlin

**Abstract:** Much applied research relies on multi-item self-report instruments. Drawing from recent cognitive theories, it was hypothesized that the items preceding a self-report item, its item context, can generate cognitive carryover and prompt context-consistent responses. These hypotheses were tested in 2 investigations: a field experiment involving 431 employees of a nonprofit urban hospital and a laboratory replication involving 245 undergraduate business students who held full- or part-time jobs. In both studies, evaluatively neutral items were placed in specially arranged blocks of uniformly positive, uniformly negative, or randomly mixed items on 3 modified Job Descriptive Index scales. Responses to the neutral items differed across the 3 forms, but scale-level psychometric properties remained unchanged. The implications of these results for a variety of self-report measures in organizations are discussed.

**Title: Underreporting of Trips in Telephone Interview Travel Surveys**

**Pub:** TRR 1412, 1993, pp. 90-94

**Auth:** Mazen Hassounah, Loy-Sai Cheah, Gerald Steuart

**Abstract:** Results of a research project on underreporting of trips in telephone interview household travel surveys arising from memory lapses and the use of proxies are presented. On the basis of a survey of approximately 61,000 households in the greater Toronto area, the effects of these two factors on reported automobile mobility characteristics were analyzed with respect to trip characteristics and to socioeconomic characteristics of households and individual trip makers. The analysis showed trip underreporting to be the rule for short discretionary trips and trips made during off-peak periods. Using these insights, correction procedures were developed to minimize the effects of trip underreporting.

**Title: Effect of Large Monetary Incentives on Mail Survey Response Rates**

**Pub:** Public Opinion Quarterly, Vol 56, No 4, Winter 1992, pp. 442-453

**Auth:** Jeannine James and Richard Bolstein

**Abstract:** The effect of various large monetary incentives was examined in a mail survey of owners of small construction subcontracting companies. The sample was randomly divided into seven groups, each of which received either a different monetary amount enclosed with the first mailing (\$1 cash, \$5 cash, \$5 check, \$10 check, \$20 check, or \$40 check) or an offer of a \$50 check to be sent once the questionnaire was returned. These groups were compared against each other and against a control group that did not receive an incentive. Three follow-up mailings were sent to the nonrespondents in each group. The results indicate that \$1 significantly increased the response rate over the no incentive control condition regardless of the number of mailings. The response rate also increased significantly as the incentive amount increased from \$1 to \$5 and from \$5 to \$20. There was a nonsignificant difference in response rate between the \$5 check and \$5 cash groups. The promise of \$5 did not result in a significantly higher response rate than the control group. Discussion includes a cost-benefit analysis of the incentives, as well as a section about the increased "favorability" of respondents toward the survey sponsor within the large incentive groups.

**Title: Maximizing Survey Response Rates for Hard-to-Reach Inner-City Populations**

**Pub:** Social Science Quarterly, Vol 72, No. 1, March 1991, pp. 172-180

**Auth:** Kathleen Pottick and Paul Lerman

**Abstract:** Maximizing response rates of hard-to-reach population can improve survey research. In a study of inner-city families which included adolescents with problems, survey designs were systematically manipulated to determine which would produce the highest response rate. A research-team design using a journalistic-style letter and personal telephone call was found to be more effective, representative, and efficient as well as less costly than other designs. This approach required less time in the field and secured response rates comparable to those in general population household surveys in urban areas.

**Title: Measurement Biases in Panel Data**

**Pub:** Transportation, Vol 16, Issue 2, 1989, pp. 175-194

**Auth:** Henk Meurs, Leo Van Wissen, Jacqueline Lisser

**Abstract:** The objective of this paper is to examine reporting errors in panel data obtained from multi-day travel diaries. A distinction is made between within and between wave biases. The former leads to an increase in under-reporting associated with the number of days the diary is kept. The latter is related to the number of waves respondents have been

participating, so-called panel experience. These biases imply that observed mobility changes between waves are partly due to reporting errors: without controlling for them, changes in mobility cannot be inferred from the data. An important cause of these measurement errors is the increase in the number of days on which no trips at all were reported. In addition, shorter trips and less complex chains are more susceptible to underreporting. The methodology used in this paper provides a means of dealing with these problems. Attrition is taken into account by a rather simple measure. The paper concludes with a number of suggestions for sample and survey design.

**Title: Regularity and Irreversibility of Weekly Travel Behavior**

**Pub:** Transportation, Vol 14, no 3, 1987, pp. 227-251

**Auth:** Ryuichi Kitamura and Toon Van Der Hoorn

**Abstract:** Dynamic characteristics of travel behavior are analyzed in this paper using weekly travel diaries from two waves of panel surveys conducted six months apart. An analysis of activity engagement indicates the presence of significant regularity in weekly activity participation between the two waves. The analysis also shows a general lack of association between regularity in activity participation and change in person and household attributes, suggesting the presence of behavioral inertia or response lags. It is further shown that observed trip rates do not exhibit patterns that would be observed if travel behavior had no response lag and no history dependence. The results point to the needs for models that are capable of representing these aspects of travel behavior.

**Route Choice**

**Title: The Effect of Advanced Traveler Information Systems (ATIS) on Travelers**

**Pub:** TRB Paper 981436, presented at TRB, January 1998

**Auth:** Amalia Polydoropoulou and Moshe Ben-Akiva

**Abstract:** A two-stage model system of users' response to ATIS is presented. The first stage corresponds to the behavior of individuals in the market for ATIS products and services, involving awareness, and choice. The second stage corresponds to individuals' travel behavior, concerning ATIS usage and travel response. The paper focuses on quantifying the relationship between ATIS features and the perceived quality of information, usage, and travel response. This relationship depends on network characteristics, trip characteristics, demographics, and attitudes and perceptions towards travel and traffic information. Two case studies (SmarTraveler and Golden-Gate Bridge) addressing different aspects of the users' response to ATIS and employing different data collection and modeling methodologies are presented. The results of these case studies are integrated into a comprehensive model system predicting users' response to alternative ATIS.

**Title: An On-the-Road Comparison of In-Vehicle Navigation Assistance Systems: The FAST-TRAC Troika Study**

**Pub:** Four Project Reports Issued by the University of Michigan, Transportation Research Institute, 1997.

**Auth:** David Eby, Lidia Kostyniuk, Carl Christoff, Michelle Hopp, and Frederick Streff

**Abstract:** The FAST-TRAC project is a multi year implementation and evaluation of an ITS in Southeastern Michigan and has two main components: An advanced traffic-management system and two distinct in-vehicle ATIS, Ali-Scout and TetraStar. The purpose of the User Perceptions and Behaviors element of FAST-TRAC is to understand how people use and what they think about the ATIS component of FAST-TRAC. The purpose of the present investigation was to compare not only how people use and what they think about these two specific systems and a third system using Written Instructions, but also to compare performance and what people think about three distinct types of in-vehicle navigation-assistance systems when the systems are used concurrently under identical conditions on the road. Identical conditions were achieved by having triplets, or troikas, of people driving similar vehicles at the same time to the same destinations, while tracking all vehicles through satellite positioning. One person in the troika used Ali-Scout, one used TetraStar, and one used Written Instructions. Driver familiarity with area and traffic conditions were also investigated. Results of the comparison are presented in the first report; the other three reports contain evaluations of user perceptions and behaviors.

**Title: Stated and Reported Route Diversion Behavior: Implications of Benefits of ATIS**

**Pub:** TRR 1464, 1994, pp. 28-35

**Auth:** Asad Khattak, Adib Kanafani, and Emmanuel Le Colletier

**Abstract:** Advanced Traveler Information System (ATIS) user benefits are estimated from a survey of commuting behavior undertaken in the San Francisco Bay Area in 1993. Reported and stated responses to unexpected congestion are used to determine the commuters who would directly benefit from the qualitative, quantitative, predictive, and

prescriptive ATIS information. Under incident conditions, ATIS quantitative delay information may induce about 40 percent of the commuters to change their route to work, mostly the people with the greater diversion opportunities, knowledge of more alternative routes, and lower congestion levels on their best alternative route. The travel time savings achieved by ATIS-induced route diversion (with quantitative information) is calculated and translated into monetary benefits. The value of time used is a function of personal income and of the time savings. The frequency of annual diversion is estimated from the time elapsed since the last incident. The potential annual benefits from ATIS route diversion, applicable to about 40% of commuters in the Golden Gate Bridge corridor, range from \$124 to \$324 per person, depending on the weight assumed for delay.

**Title: Analysis of Drivers' Information Preferences and Use in Auto Travel: Implications for ATIS**

**Pub:** Proceedings of the IEEE-IEE Veh Nav and Info Systems Conference, 1993, pp. 414-418

**Auth:** Fredrick M. Streff and Richard R. Wallace

**Abstract:** This paper presents results from the analysis of a survey of drivers conducted in the state of Michigan. The emphasis is on drivers' information use and preferences. Individual and group differences in use of and preferences for traveler information are discussed, as are perceived problems with current sources of travel and traffic information. The findings, which are discussed in the context of past research on spatial behavior, provide insights into what users may find attractive about ATIS and what ATIS may need to offer in order to attract users. Particular attention is paid to the needs of drivers while traveling in unfamiliar areas.

**Title: Functional Measurement of Route Choice Behavior: A Study of Commuting Cyclists in the Netherlands**

**Pub:** Behavioural Research for Transport Policy, 1986, pp. 289-305

**Auth:** Mark Bradley and Piet Bovy

**Abstract:** An application of scenario-based, or "stated preference" survey and analysis techniques is described in the context of cyclists' route choice. Route choice modeling with observed choice data is hampered by the cost of processing network data, and by the difficulty of assessing the alternative routes and the perceived attributes of the routes considered by individual travelers. An alternative approach is to obtain stated evaluations of well-defined hypothetical routes. Such data was collected from commuting cyclists in the city of Delft in the Netherlands, and analyzed using functional measurement to measure the relative importance placed on route attributes such as time, traffic level and surface quality. Though the techniques used are well founded in the marketing and psychology literature, the route choice context raises issues which are particularly important for their application in transport policy analysis. The stated preference framework is discussed, followed by a description of the route choice survey and results, concluding with a discussion of the applications of such an approach in policy analysis.

## **Selected Manuals / Reports / Journals / Conference Proceedings**

**Title: Travel Survey Manual**

**Pub:** Prepared for US DOT, FTA, FHWA, US EPA

**Auth:** Cambridge Systematics, Inc.

**Title: The FAST-TRAC Troika Study**

**Pub:** Four Project Reports Issued by the University of Michigan, Transportation Research Institute

**Auth:** David Eby, Lidia Kostyniuk, Carl Christoff, Michelle Hopp, and Frederick Streff

**Title: Light-Duty Vehicle Driving Behavior: Private Vehicle Instrumentation**

**Pub:** Four Reports by Radian Corporation, Austin, TX, 1992

**Auth:** T. H. DeFries and S. Kishan

**Title: Household Surveys: New Concepts and Research Needs**

**Pub:** Conference Proceedings 10, 1996

**Auth:** TRB/NRC

**Title: Proceedings of the 6th and 7th International Conference on Travel Behaviour**

**Pub:** Conference Proceedings, 1991 and 1994

**Auth:** IATBR

**Note:** The Table of Contents for each Conference Proceedings are in the back of Book 4

**Title: Innovations in Travel Survey Methods**

**Pub:** TRR 1412, 1993

**Auth:** TRB

**Title: Innovations in Travel Survey Methods**

**Pub:** TRR 1097, 1986

**Auth:** TRB

**Title: Travel Measurement Issues**

**Pub:** TRR 987, 1984

**Auth:** TRB