Institute of Transport Studies
Graduate School of Business
The University of Sydney

STRICTLY CONFIDENTIAL

REDESIGN OF TRANSPORT STUDY GROUP'S STRATEGIC TRAVEL AND INFORMATION MODEL SYSTEM (STIMS): VOLUME II

DRAFT REPORT

September 20, 1994

TABLE OF CONTENTS

Appendix A

Stakeholder Interviews and Workshop Participants

A.1 The 11 Stakeholder Groups Interviewed

Organisation	Representatives
NRMA	Alan Finlay, Senior Manager, Transport Policy and Economics David Anderson, Transport Analyst
Bus and Coach Association (NSW)	Keith Todd, Owner, Glenorie Buses
Environment Protection Agency (NSW)	Lisa Corbyn, Director EPA Alethia Morrison, Policy Planner
Sydney Buses	Stephen Timbrell Richard West
Roads and Traffic Authority (NSW)	Brian Watters, Regional Development Manager, Sydney Region Malcolm Cross, Network Planner, Sydney Region
Penrith City Council	Bruce McDonald, Director of Environmental Planning Peter Adams, Transportation Planner
Department of Transport (NSW)	John Walker, Director-general of Transport John Bryan, Director of Planning
NSW Treasury	Frank Jordan, Senior Economist Danny Graham, Senior Economist
Department of Planning (NSW)	Dr Joan Vipond, Divisional Manager, Metropolitan Planning Division Shane Neugent, Urban Planning Manager
State Rail Authority of NSW	Barry Garnham, A/Director, Planning and Access
NSW Road Transport Association	Peter O'Connor, Executive Director

A.2 Participants at the Day One Workshop

• Mr David Anderson
Senior Transport Analyst
N R M A
151 Clarence Street
SYDNEY NSW 2000
Tel: (02) 260 9949
Fax: (02) 260 8485

Mr John Bryan
Director, Planning Projects
Transport Planning Division
NSW Department of Transport
GPO Box 1620
SYDNEY NSW 2000
Tel: (02) 268 2837
Fax: (02) 268 2907

• Mr Jim Cox
Principal Advisor
Government Pricing Tribunal
GPO Box 3400
SYDNEY NSW 2001
Tel: (02) 290 8491
Fax: (02) 290 2061

• Assoc Prof Garland Chow
University of British Columbia
Faculty of Commerce and Business Administration
2053 Main Mall
VANCOUVER, BC V6T 1Z2
CANADA
Tel: (604) 822 8328
Fax: (604) 822 8521

• Mr Jim Donovan
Secretary
Action for Public Transport
PO Box K606
HAYMARKET NSW 2000
Tel: (02) 692 3516
Fax: (02) 692 3838

• Prof David Hensher
Director
Institute of Transport Studies
Graduate Sch of Business C37
University of Sydney
NSW 2006
Tel: (02) 550 8631
Fax: (02) 550 4013

• Mr Ian Kearns
CityRail Planning and Services
11th Floor Xerox House
815-821 George Street
HAYMARKET NSW 2000
Tel: (02) 219 4387
Fax: (02) 219 4581

• Mr David Kilsby
Associate
Sinclair Knight Merz
PO Box 164
ST LEONARDS NSW 2065
Tel: (02) 436 7222
Fax: (02) 438 4794

• Ms Alethea Morison
Senior Policy Officer
Policy Integration
E P A
PO Box 1135
CHATSWOOD NSW 2057
Tel: (02) 325 5594
Fax: (02) 415 3098

• Mr Bob Nairn
R J Nairn and Partners
20-22 Walder Street
Belconnen Mail Delivery Centre
BELCONNEN ACT 2617
Tel: (06) 251 7926
Fax: (06) 251 7927

• Mr Michael Seery
Senior Economist
Government Pricing Tribunal
Level 1, 140 Sussex Street
SYDNEY NSW 2000
Tel: (02) 290 8421
Fax: (02) 290 2061

• Mr Rod Tudge
Manager, Systems Performance
Transport & Network Development Branch
Roads & Traffic Authority
PO Box K198
HAYMARKET NSW 2000
Tel: (02) 218-6612
Fax: (02) 218-6167

• Mr Upali Vandebona
Lecturer
Department of Transport Engineering
THE UNIVERSITY OF NEW SOUTH WALES 2052
Tel: (02) 697 5056
Fax: (02) 633 2188

• Mr Neil Walker
Roads and Traffic Authority
Transport & Network Development
PO Box K198
HAYMARKET NSW 2000
Tel: (02) 218 6386
Fax: (02) 218 6167

• Prof Marcus Wigan
Professor of Management
Institute of Transport Studies
Graduate Sch of Business C37
Uni of Sydney NSW 2006
Tel: (02) 550 8640
Fax: (02) 550 4013

A.3 Participants at the Day Two Workshop

• Ms Helen Battellino
Lecturer Transport Management
Institute of Transport Studies
Graduate Sch of Business C37
Uni. of Sydney NSW 2006
Tel: (02) 550 8632
Fax: (02) 550 4013

• Mr John Bryan
Director, Planning Projects
Transport Planning Division
NSW Department of Transport
GPO Box 1620
SYDNEY NSW 2000
Tel: (02) 268 2837
Fax: (02) 268 2907

• Mr Peter Gipps
Division of Building & Construction
CSIRO
PO Box 56
HIGHETT VIC 3190
Tel: (03) 252 6000
Fax: (03) 2526249

• Prof David Hensher
Director
Institute of Transport Studies
Graduate Sch of Business C37
University of Sydney
NSW 2006
Tel: (02) 550 8631
Fax: (02) 550 4013

• Mr Michael Johnson
Environment Protection Authority
Environment Protection Officer
PO Box 29
LIDCOMBE NSW 2141
Tel: (02) 795 5018
Fax: (02) 649 8768

• Mr William Mac Dougall
Director Roads & Traffic
Travers Morgan
PO Box 396
LINDFIELD NSW 2070
Tel: (02) 416 9511
Fax: (02) 416 1321

• Mr Shane Nugent
Department of Planning
Metropolitan & Regional Management Branch
GPO Box 3927
SYDNEY NSW 2001
Tel: (02) 391 2289
Fax: (02) 391 2373

• Ms Virginia Sapkota
Survey Project Officer
Transport Study Group NSW
GPO Box 1620
SYDNEY NSW 2001
Tel: (02) 268 2934
Fax: (02) 268 2853

• Mr S Stewart
Transit NZ
PO BOX 5084
Wellington
NEW ZEALAND
Tel:
Fax: 0015+64 (4) 496 6666

• Mr Matthew Wilson
Supervising Engineer
Network Analysis
Roads and Traffic Authority
Traffic Technology Branch
PO Box K918
HAYMARKET NSW 2000
Tel: (02) 662 5196
Fax: (02) 662 5893

A.4 Participants at the Day Three Workshop

• Ms Gillian Akers
Principal Transport Planner
Snowy Mountains Engineering Corporation
PO Box 1052
NORTH SYDNEY NSW 2059
Tel: (02) 955 1222
Fax: (02) 955 6113

• Mr John Bryan
Director, Planning Projects
Transport Planning Division
NSW Department of Transport
GPO Box 1620
SYDNEY NSW 2000
Tel: (02) 268 2837
Fax: (02) 268 2907

• Mr Malcolm Cluett
11a Novara Crescent
COMO NSW 2226
Tel: (02) 589 0226

• Mr Peter Crosby
Zone Planner - North Coast
Roads & Traffic Authority
PO Box 576
GRAFTON NSW 2460
Tel: (066) 40 1342
Fax: (066) 40 1301

• Mr Robby Coleman
Greenpeace
PO Box 800
SURRY HILLS NSW 2010
Tel: (02) 211 4066
Fax: (02) 211 4123

• Mr C Eiser
Manager, Mobile Sources
E P A
Locked Bag 1502
BANKSTOWN NSW 2200
Tel: (02) 795 5049/ 5000
Fax: (02) 643 2466

• Mr T. Floyd
Friends of the Earth
104 Bathurst Street
SYDNEY NSW 2000
Tel: (02) 211 3953
Fax: (02) 283 2005

• Chris Ford
Development &
Road Safety Manager
Roads & Traffic Authority
PO Bx 558
BLACKTOWN NSW 2148
Tel: (02) 13 2213
Fax: (02) 831 0155

• Prof David Hensher
Director
Institute of Transport Studies
Graduate Sch of Business C37
University of Sydney
NSW 2006
Tel: (02) 550 8631
Fax: (02) 550 4013

• Mr Allan Hoskins
Executive Director
Transport Planing
& Projects Division
NSW Department of Transport
GPO Box 1620
SYDNEY NSW 2000
Tel: (02) 268 2959
Fax: (02) 268 2206

• Mr M Lane
Superintendent,
Traffic Operation
Level 4, Ferguson Centre
130 George Street
PARRAMATTA NSW 2150
Tel: (02) 689 7216
Fax: (02) 689 7205

• Mr Leo Marquez
Housing & Urban Development
C S I R O
56 Graham Road
HIGHETT VIC 3190
Tel: (03) 252 6249
Fax: (03) 252 6208

• Mr Gary McGregor
Department of Planning
175 Liverpool Street
SYDNEY NSW 2000
Tel: (02) 391 2339
Fax: (02) 391 2228

• Mr Frank Milthorpe
Principal Research Analyst
Institute of Transport Studies
Graduate Sch of Business C37
Uni of Sydney NSW 2006
Tel: (02) 550 8644
Fax: (02) 550 4013

• Mr Robert W Morrow
Chairman
N.S.W. Taxi Council
Level 4, 152-162 Riley St
EAST SYDNEY NSW 2010
Tel: (02) 398 6049
Fax: (02) 360 1675

• Mr Tim Raimond
Research Analyst
Institute of Transport Studies
Graduate Sch of Business C37
University of Sydney
NSW 2006
Tel: (02) 550 8642
Fax: (02) 550 4013

• Dr Nariida Smith
Director Transport Management Program
Institute of Transport Studies
Graduate Sch of Business C37
University of Sydney
NSW 2006
Tel: (02) 550 8636
Fax: (02) 550 4013

• Mr Peter Wade
Roads & Traffic Authority
Transport & Network Development Branch
PO Box K198
HAYMARKET NSW 2000
Tel: (02) 218 6617
Fax:(02) 218 6167

• Mr Brian Watters
Roads & Traffic Authority
PO Bx 558
BLACKTOWN NSW 2148
Tel: (02) 13 2213
Fax: (02) 831 0155

Appendix B

Consultative Approach Correspondence

The Invitation to the Stakeholders to Participate in the One-on-One Interview

Dear .....

The Institute of Transport Studies (ITS) has been engaged by the NSW Department of Transport to develop a strategic travel information and model system for urban transport, passenger and freight.

The key activities of the inquiry are interviews with key stakeholders such as yourself followed by a series of workshops to which a wider set of stakeholders will be invited to participate and contribute to the discussions on appropriate directions for change in line with the following broad objectives:

> To increase the policy relevance and sensitivity of existing travel and transport forecasting procedures and their ability to respond to emerging issues including environmental concerns, growth management, and changes in personal, household and firm activity patterns, along with the traditional transport issues
>
> To redesign the travel forecasting process to reflect today's traveller and freight flow behaviour, to respond to greater information needs placed on the planning and forecasting process, and to take advantage of changes in data collection technology; and
>
> To make travel model results (explanatory and forecasting) more useful to decision makers.

The aim of the stakeholder interviews is to identify the policy-based obligations of the organisation and the role that travel and transport information does play and might contribute in the future to the planning and decision-making process. We would like to invite you to participate in the stakeholder interviews. To give you some idea of the issues we want to address, a series of prompts will be used - they are set out in the attachment to this letter. However we will allow plenty of flexibility in the interview so that you can express your views on all the issues which you believe are important to the inquiry process.

We do hope that you are available for a stakeholder interview. The interview should take about 1 to 1.5 hours. In the next two weeks a member of the ITS team will call you to make an appointment at a time and location which is convenient for you. The interviews will be undertaken by senior staff from ITS. If you wish to invite up to two other colleagues they would be most welcome.

We look forward to meeting with you.

Kind regards

David A. Hensher

Attachment 1 of The Stakeholder Interview Letter of Invitation

The stakeholder interviews will be used to identify current uses of transport and planning data, with particular reference to types of information, the form in which it is made available, the source(s), who does the work in the organisation with the information, how the information is used in applications and how it contributes to the planning and decision-making process. Specific applications can be drawn on to identify issues which are not able to be (adequately) addressed with the available data and models - 'holes and gaps', barriers to securing suitable information, and looking to the future - the types of planning the organisation would like to be involved in and the information requirements necessary to be able to achieve the planning outcomes.

Identification of key research questions of the organisation will be highlighted with a current view on the types of information required to assist in answering these questions. A wish list for the future will be identified as well as views sought on how one might restructure organisationally/institutionally to improve the government's service role in the provision of travel information and models.

The interview issues are as follows:

1. Definition of Transport Information and Modelling Systems (to ensure we all understand the context)
2. Key research questions your organisation is interested in at present and in the last few years
3. What use you/your organisation makes of travel data and models in planning/policy etc
4. Where information is sourced from for planning/policy advice
5. Frustrations and satisfaction in the past in accessing particular types of information (e.g. what it Is, who you dealt with, how long it took to get the material and the extent to which the material was suitable or a compromise)
6. Wish list of types of information you/your organisation would find particularly useful
7. Particular types of information questions which you cannot get answers for?
8. General and open discussion - other issues and comments

Invitation to Participate in the Workshop

Dear .....

The Institute of Transport Studies (ITS) has been engaged by the NSW Department of Transport to develop a strategic travel information and model system for urban transport, passenger and freight.

The key activities of the inquiry are interviews with a few stakeholders followed by a series of workshops to which a wider set of stakeholders are to be invited to participate and contribute to the discussions on appropriate directions for change in line with the following broad objectives:

> To increase the policy relevance and sensitivity of existing travel and transport forecasting procedures and their ability to respond to emerging issues including environmental concerns, growth management, and changes in personal, household and firm activity patterns, along with the traditional transport issues
>
> To redesign the travel forecasting process to reflect today's traveller and freight flow behaviour, to respond to greater information needs placed on the planning and forecasting process, and to take advantage of changes in data collection technology; and
>
> To make travel model results (explanatory and forecasting) more useful to decision makers.

The aim of the stakeholder interviews conducted in late July and early August was to identify the policy-based obligations of the organisation and the role that travel and transport information does play and might contribute in the future to the planning and decision-making process. This information together with the first round of an international Delphi exercise with over 50 analytical and applications experts has been used to prepare a discussion paper for the workshops.

We would like to invite you to participate in a stakeholder workshop. The workshop is to be held in the Offices of the Roads and Traffic Authority in Centennial Plaza (Elizabeth Street) from 10 am until 4 pm on:

Tuesday 30 August
Wednesday 31 August
Friday 2 September

Lunch will be provided. We do hope that you are available to attend the workshop. Enclosed is a copy of a very short survey form. A discussion paper will be distributed to you prior to the workshop. To enable us all to get maximum benefit from the workshop, we encourage you to read the discussion paper in advance. Some of the themes which we would like to address during the workshop are:

1. Definition of Transport Information and Modelling Systems (to ensure we all understand the context)
2. Key research questions your organisation is interested in at present and in the last few years
3. What use you/your organisation makes of travel data and models in planning/policy etc
4. Where information is sourced from for planning/policy advice
5. Past experience in accessing particular types of information (e.g. what it is, who you dealt with, how long it took to get the material and the extent to which the material was suitable or a compromise)
6. Your views on the preferred means of accessing travel and transport information or models (Wish list of types of information you/your organisation would find particularly useful)
7. Particular types of information questions which you cannot get answers for.
8. General and open discussion - other issues and comments

Please complete the survey form prior to the workshop.

We look forward to your participation. Please call Tim Raimond on 550 8642 or fax 550 4013 to indicate your availability.

Appendix C

Survey of Transport Professionals

What do you think?

The Institute of Transport Studies (ITS) is undertaking a review of strategic travel information and model systems for **urban** transport, both passenger and freight.

An important activity of the inquiry is a Delphi exercise. The aim of the *Delphi Activity* is to identify the state of the art and the state of practice in areas of information associated with travel models and travel data; and to establish the important linkages between the state of play and its relevance to the transport planning and decision-making process.

A selected set of analytical and applications experts, including yourself, are invited to give your views in line with the following broad objectives:

- To increase the policy relevance and sensitivity of existing travel and transport forecasting procedures and their ability to respond to both traditional and emerging transport issues;
- To redesign the travel forecasting process to reflect today's traveller and freight flows behaviour, to respond to greater information needs placed on the planning and forecasting process, and to take advantage of changes in data collection technology; and
- To make travel model results (explanatory and forecasting) more useful to decision makers.

We would like to invite you to participate in the survey exercise. The exercise should take no more than 30 minutes of your time.

We would ask you to fax your completed form by August 5 to Tim Raimond on:

Fax: **+ 61 2 550 4013** (if outside Australia)
or **(02) 550 4013** (if in Australia)

We will then analyse the data content and provide a second (and final round) feedback to you, seeking some further comment. A final report of the findings will be sent to you upon completion of the exercise.

We look forward to receiving your completed survey form.

Kind regards

David A. Hensher

SURVEY OF TRANSPORT PROFESSIONALS

Section 1: PERSONAL DETAILS

Please fill in the following personal details, or attach a CV and business card containing the information in questions 1 to 4.

1. Name

Title:.....

Initials .....

Surname:.....

details)

2. Contact Details

Telephone.....

Facsimile.....

Email.....

(please include country codes for above

3. Full mailing address:

.....

.....

.....

.....

4. Highest educational qualification

Type..... Year.....

University:..... Country.....

5. Number of years in transport research (or related) field: .....years

This question is optional but useful.

6. Organisations worked for in last 5 years and duration with each organisation:
(*No acronyms please*)

Most recent.....for..... years

Second most recent.....for..... years

Third most recent.....for..... years

7. How would you describe your expertise? *Tick one or more*

☐ Basic research

☐ Applied research

☐ Policy analysis

Section 2: POLICY AREAS

The table below lists a range of policy areas. In the columns we ask you to rank the five most important answers to each question from 1 to 5 (1 = most important)

If there are some important transport policy areas which you would like to add, you may do so in the space provided at the bottom of the table. Considering the issues in the table (or adding your own):

8. Which transport issues have been *most important* in the LAST FIVE years in terms of planning and policy in your country? *Please rank in column Q.8*

9. Which areas do you believe will be high agenda items over the NEXT FIVE years in your country? *Please rank in column Q.9*

10. Which OUGHT to receive greater attention in the next 5 years? *Please rank in column Q.10*

11. Which areas do you think would be best studied via international funding and agencies? *Please rank in column Q.11*

	Q.8	Q.9	Q.10	Q.11
Transport Pricing				
Road maintenance				
Road infrastructure investment/toll roads				
Local Area Traffic Management				
Traffic control systems				
Travel demand management (urban-wide)				
Transport safety				
Busways and light rail				
Public transport infrastructure investment				
Public transport operations				
Community Service Obligations				
Transport financing				
Deregulation/privatisation/out-sourcing				
Alternative fuelled public transport (buses)				
Alternative fuelled automobiles				
IVHS				
Integrated land use – transport strategy				
Telematics/telecommuting				
Airport planning and strategy				
Ports transport strategy				
Environmental impact assessment				
Evaluation				
Institutional reform				
Consultation				
Other:				
Other:				
Other:				
Other:				
Other:				

Section 3: SKILLS

12. What, in your view, are the range of transport-related skills required to plan and evaluate a transport system/network for a large city? *Please list up to 5 that should be provided in-house by a government agency, and up to 5 that should be contracted out.*

IN-HOUSE SKILLS	CONTRACTED OUT SKILLS
1.	1. .....
2.	2. .....
3.	3. .....
4.	4. .....
5.	5. .....

13. What software do you/your organisation use for:

	Don't know	Not Applic.
Travel model data preparation/management:	☐	☐
Travel model estimation:	☐	☐
Travel model calibration:	☐	☐
Travel model application:	☐	☐
Network assignment:	☐	☐
GIS:	☐	☐
On-site data collection:	☐	☐
Evaluation	☐	☐
Consultation support	☐	☐

14. Where, in your view, does the expertise in your country lie in the following skill areas? *Please rate each organisations' skills from 1 to 10 (1=very good, 10=very poor)*
Please answer in percentages within:

A = Federal Government
B = State/Provincial Government
C = Local Government
D = Universities
E =Subsidised Research Organisations
F = Consultants

Skill Areas	A	B	C	D	E	F	Q.15	Q.16
Project management								
Survey design								
Sample design								
Questionnaire design								
Data collection								
Data editing and entry								
Data preparation								
Data management								
Highway networks								
Public transport networks								
Model estimation								
Model calibration								
Travel forecasting								
Training								
Model application								
Transport economics								
Consultation								
Project evaluation								
Policy analysis								
Tabular analysis								

15. In the previous table, ideally, where should the expertise lie? *Please write in column labelled Q.15 the letter A-F where you think the greatest level of expertise in each skill area should most usefully lie.*

16. In the previous table, which areas of expertise do you think should be resident in a State/Provincial Government transport research organisation (even if they are not viewed as the major provider)? *Please tick in column labelled Q.16*

17. Do you have any comments on any issue that you wish to make at this stage?

☐ No ☐ Yes:.....

.....

.....

.....

.....

Section 4: DATA

18. What are the most common frustrations you have faced in accessing information from:

a) government agencies? *List up to 5*

1. .....
2. .....
3. .....
4. .....
5. .....

b) private data agencies? *List up to 5*

1. .....
2. .....
3. .....
4. .....
5. .....

c) universities? *List up to 5*

1. .....
2. .....
3. .....
4. .....
5. .....

d) other sources (*please specify*)

Source:..... Problems: .....

.....

Source:..... Problem: .....

.....

19. Where do you usually get your travel data (for transport planning and evaluation)? *List up to five sources used in the last two years*

Source 1:.....

Source 2:.....

Source 3:.....

Source 4:.....

Source 5:.....

20. Who collect useful primary data on travel in your country? *Please rank the 4 most useful, 1=most useful*

- ☐ government agencies
- ☐ private collection agencies
- ☐ universities
- ☐ other (*please specify*) .....
- ☐ other (*please specify*) .....

21. What, in your view, are the most important core urban travel data items that should be collected to service the transport planning and research community? *List up to 5 broad data categories*

1. .....
2. .....
3. .....
4. .....
5. .....

22a. What, in your view, is a desirable mix of data collection strategies for this core data? *Please give percentages in boxes below*

22b. For each strategy, how often would you like to see reinterviewing?

	a.		**b.**	
Single cross section	☐	%	every ☐	years
Repeated cross section[1]	☐	%	every ☐	years
Longitudinal panel[2]	☐	%	every ☐	years

Section 5: RESEARCH

23. RATE the following areas of basic research in terms of their potential impact in applications aimed at *improving* our understanding and forecasting of travel behaviour (you may add other important research areas) *Please rate on a scale of 1 to 10, where 1 = very unimportant, 10 = very important. Write DK if unsure or unfamiliar with technique.*

- ☐ Dynamic traffic assignment methods
- ☐ Stated preference and stated choice methods
- ☐ Activity modelling (time budgets, trip chaining, household constraints, multi-purpose trips)
- ☐ Valuation of travel time savings
- ☐ Valuation of environmental impacts (noise, air quality, visual, aesthetic, etc.)
- ☐ Integrating environmental variables in travel behaviour models

1 regular survey of a new sample drawn from the same population as previous samples
2 regular survey of the same sample with some refreshment to allow for attrition

- ☐ Advanced static discrete choice models (e.g simulated moments multinomial probit)
- ☐ Dynamic discrete-choice modelling (allowing for state dependence, heterogeneity etc.)
- ☐ Joint estimation of discrete-continuous choice models
- ☐ Joint modelling of revealed and stated choices
- ☐ Attitudinal and stated intention measurement and modelling
- ☐ Traveller Information Systems/Intelligent Vehicle Highway Systems
- ☐ Alternative travel survey sampling designs
- ☐ Travel survey collection strategies (cross-section, panels etc.)
- ☐ Geographic information systems as spatial data base managers
- ☐ Vehicle operating cost models
- ☐ Vehicle ownership/purchase models
- ☐ Location based choice models (eg residential, workplace location choices)
- ☐ Duration modelling to handle the timing of change
- ☐ Equilibration procedures for the various markets (travel, vehicles, location)
- ☐ Deriving origin-destination matrices from traffic counts
- ☐ Decision-support systems to embed a model system into an operational framework
- ☐ Methods for systematically segmenting travel markets
- ☐ Model transferability in time and space
- ☐ Algorithms for more efficient estimation of choice and demand models
- ☐ Improved measures of accessibility, mobility and benefit
- ☐ Descriptive studies of travel behaviour
- ☐ Relationships between transport and quality of life
- ☐ Qualify and efficiency of data collection methods
- ☐ Scheduling algorithms
- ☐ Pricing/ticketing systems for public transport
- ☐ Other: .....
- ☐ Other: .....
- ☐ Other: .....
- ☐ Other: .....
- ☐ Other: .....

Section 6: MODELS

24. Rate on a scale of 1 - 10 the following travel models in terms of their relative importance in an integrated model system for *passenger transport*. *1=very unimportant, 10=very important*

a) Commuting:

- ☐ mode choice
- ☐ route choice (automobile)
- ☐ route choice (public transport)
- ☐ trip time switching/departure time choice
- ☐ workplace location choice
- ☐ frequency of travel
- ☐ telecommuting choice
- ☐ compressed work week choice
- ☐ parking location choice
- ☐ vehicle occupancy number choice (carpooling)
- ☐ vehicle availability choice
- ☐ trip chaining choice
- ☐ ticket type choice
- ☐ other (*write in*):.....
- ☐ other (*write in*):.....

b) Non-Commuting:

- ☐ mode choice
- ☐ departure time choice
- ☐ route choice (automobile)
- ☐ route choice (public transport)
- ☐ frequency of travel by trip purpose
- ☐ destination choice by trip purpose
- ☐ parking location choice
- ☐ vehicle availability choice
- ☐ trip chaining choice
- ☐ ticket type choice
- ☐ air pollution
- ☐ scheduling
- ☐ accessibility
- ☐ other (*write in*):.....
- ☐ other (*write in*):.....

c) Household activity:

- ☐ residential location choice
- ☐ dwelling type choice (detached, semi-detached house, flat/apartment, town house/villa)
- ☐ tenure type choice (own, buying, renting)
- ☐ automobile type choice
- ☐ fleet size choice
- ☐ access to company car 'choice'
- ☐ annual vehicle use (kms)
- ☐ Proportion of annual vehicle kms for commuting, urban non-commuting and non-urban use
- ☐ accessibility
- ☐ other (*write in*):.....
- ☐ other (*write in*):.....

d) Firm activity:

- ☐ workplace location choice
- ☐ industrial location
- ☐ land use models
- ☐ other (*write in*):.....
- ☐ other (*write in*):.....

25. Rank on a scale of 1 - 10 the following travel models in terms of their relative importance in an integrated model system for *freight transport and commodity demand*. *1=very unimportant, 10=very important*

- ☐ destination choice
- ☐ mode choice
- ☐ frequency choice/trip generation
- ☐ carrier type (private, public, independent owner etc.)
- ☐ route choice
- ☐ time of day of travel choice
- ☐ truck/light vehicle type choice
- ☐ depot/warehouse location choice
- ☐ other (*write in*):.....
- ☐ other (*write in*):.....
- ☐ other (*write in*):.....

26. What do you believe are the most important criteria to equilibrate the following model systems? *List up to 3*:

No Idea

Travel choice model system:..... ☐

.....

.....

Location/Land use model system:..... ☐

.....

.....

Automobile market model system:..... ☐

.....

.....

27. Do you have any comments on any issue that you wish to make at this stage?

☐ No ☐ Yes:.....

.....

.....

.....

.....

.....

Section 7: OPINION

The following statements provide divergent views on where the state of practice should reside. For each statement please indicate:

28. whether you agree or disagree or have no view
A = agree, D = disagree, N = no view

29. whether implementation is feasible today for the approach in (or solution to) the statement (assuming available resources)
F = feasible, NF = not feasible, DK = don't know

***30*. whether you have implemented the approach (or solution) in recent years (or are in the process of doing so)**
I = implemented, PI = in process of implementing, NI = not implemented

Please note: where questions are not applicable, the cells are shaded

Statements	Q.28	Q.29	Q.30
1. I believe activity based rather than a trip-based approaches to travel data collection and modelling are more useful.			
2. I believe longitudinal data collection and modelling techniques should replace single cross-section static techniques			
3. Focus groups should be used to better understand household decision-making.			
4. Surveys should make greater use of stated preference questions as a means of gaining increasing understanding of potential responses to contexts not always observed at the time of the survey.			
5. I think GIS technology for database management and model integration is the preferred way to progress.			
6. Well-known, transportable and easy to use software for data management is the way to go for data holding in a readily reproducible form. For example SPSS headers and flat files and procedures (not save files). This is more flexible than data base management systems solutions.			
7. I think stochastic simulation should replace deterministic aggregate extrapolation.			
8. I would like to see traffic simulation models linked with travel demand models.			
9. The use of disaggregate choice models should be expanded.			
10. Statistical correlations of variables aggregated to some spatial unit are currently used to develop stable parameters for travel demand forecasting. Simulation techniques should be used instead on the specific trips made by individual and firms to develop stable parameters, and combine them with sample enumeration procedures to produce areawide traffic patterns			
11. Many of the travel choices that are currently modelled as sequential decisions can be more effectively modelled as joint choice decisions using traffic assignment models.			
12. A city needs only a peak hour(s) model.			
13. A city need both a 24 hour and peak(s) model.			

14. Models such as mode-choice should be estimated using a disaggregate (individual) model.			
15. Disaggregate models should be implemented using zonal averages.			
16. Stochastic user equilibrium should be extended to dynamic assignment.			
17. Current traffic assignment models should be replaced by a dynamic assignment process which allows differentiation of network level of service by discrete time periods, and computes flows of downstream links as functions on connecting links in prior time periods.			
18. Peak hour traffic models are a better option than 24 hour models.			
19. I prefer to use traffic assignment models with integrated traffic simulation rather than stand along assignment models			
20. Every rail line should be coded in the network.			
21. Bus routes are represented as "Generic" routes to reflect a corridor.			
22. Fuzzy set theory should be used to model user perceptions.			
23. The use of neural networks or similar rule based simulation approaches should be expanded.			
24. Classifying household and firm activities into mandatory, flexible and optional, based on their criticality in fulfilling the household's or firm's needs is a useful way of recognising the ability to vary such activities.			
25. Developing a model in-house rather than purchasing it from another source leads to better planning/forecasting results.			
26. There should be a transport research data library established in each country which can be accessed worldwide.			
27. All core travel data for an urban area should be collected by one agency.			
28. Too much emphasis in application is placed on long-term forecasting to the relative neglect of short to medium term forecasting.			
29. The preferred evolution of travel surveys is a survey methodology focussing on meeting immediate agency objectives with minimum hassle; this involves replacing the 'dinosaur' with a family of integrated 'insect' surveys oriented towards smaller, faster, low-budget surveys usually with a single goal.			

31. If you have any comments on an issue we may have overlooked, we would welcome them:

.....

Thank you for your support.

PLEASE FAX BY AUGUST 5 TO TIM RAIMOND ON:

+61 2 550 4013 (International)

OR (02) 550 4013 (within Australia)

Appendix D

Data as Property

D.1 INTRODUCTION

It is not entirely clear that all spatial databases can be copyrighted in Australia. The law covering software and databases is still being clarified, and different countries have treated data and programs differently. The wide use of copyright (rather than patent) law has not helped. Computers operate on a combination of data and programs to determine how the data held in the computer is manipulated. The legal position of programs and data have a fair amount in common, the first being the extension of copyright protection to either in an electronic form.

The impact of the Copyright Act 1968 (CAL.) on computer software was significantly affected by Apple Computer initiating the Computer Edge case in 1983 (*Computer Edge Pty Ltd v. Apple Computer (1986) 160 CLR 129*] when the High Court ruled on the decision of an earlier Court that copyright did not obtain in the machine readable forms of programs written by Apple to operate their machine. However, by that date in 1986, the Copyright Amendment Act had been passed in mid 1984, with the designation of software as 'literary works' and thus unequivocally subject to the Copyright Act.

Just before the Australian High Court decision was handed down, Reed, J. in the Federal Court of Canada held that the Canadian Copyright Act (which was in effect the Copyright Act 1911 (UK) which was the precursor to the Australian Copyright Act), did indeed extend copyright to Apple's programs and endorsed the very reasoning of the Federal Court of Australia overturned by the Australian High Court. This illustrates the problems involved in dealing even with such constructs as software, which indubitably encompass skill and creativity in an expression. Data is even harder to define and pin down firmly in terms even of authorship, let alone originality.

In the US, ***patents*** are now being issued for software, in addition to protection under a series of copyright and trade secrets cases. This move to patents raises severe problems for the community on a world wide basis, and the full impact is only now beginning to be appreciated (Garfinkle & Stallman, 1992).

Recent Australian work on data bases (Monetti, 1990) suggests that minimal originality is required for a Court to grant copyright protection to a collection of facts, although Ricketson, (1990) does not take such an extreme view. A more recent finding (*Rural Telephone Company v. Feist , 1991)* has placed a firm hold on this interpretation, and, at least for the US, has even placed Constitutional Law constraints on extending Copyright protection to data bases or collections of fact (Samuelson, 1992). Databases as a specific example of collections of facts in a machine readable form are discussed in depth by (Hughes, 1991).

D.2 MACHINE READABLE FORMATS AS VALID OBJECTS FOR COPYRIGHT

s.22 (2) of the Copyright Act 1968 (CAL) specifically provides that 'For the purposes of this Act a '*literary, dramatic or musical work that exists in the form of sounds embodied in an article or thing shall be deemed to have been reduced to a material form and to have been so reduced at the time when these sounds were embodied in that article or thing*'.

The Copyright Act 1911 (UK) had been enacted specifically to give effect to the case that a pianola roll was a copy of a musical work, as it demonstrably provided the means to execute it. The case that forced this issue (*Boosey and Hawke v. Whight [1901] Ch 122 E.C*) was a visual comparison-based decision - i.e. that this copy "could not be 'seen' to give the same idea to every person" (*West v. Francis (1882) 106 ER 1361*). The storage of a musical work in a database in the standard electrotonic MIDI format would fall into the same category if this principle was deemed to apply.

The ability and authorisation to copy computer programs (and *à fortiori* machine readable data) was the prime reason for the Computer Edge case, and the successor cases (*Ozi-Soft Pty Ltd and Ors v. Wong and Ors (1988) 10 IPR 520; Barson Computers Australasia Ltd v. Southern Technology Pty Ltd and Anor (1988) 10 IPR 597*).

The 1984 Copyright Amendment Act has a peculiar loophole [s 43a], where owners of the media on which computer programs are stored are permitted to make backup copies, and this would in general also apply to databases.

D.3 ECONOMIC IMPORTANCE OF COPYRIGHT OF CONTROL OF DATA AND SOFTWARE

The impact of holding copyright is economically critical as the copyright holder of a work presently has the right to prevent unauthorised importation or sale by other parties. This is not an unambiguous finding in the UK, but is firmly established in Australia (*Time-Life International (Netherlands) BV v, Interstate Parcel Express Co Pty Ltd (1977) 138 CLR 53; Ozi-Soft Pty Ltd op. cit.*), New Zealand and India (*Penguin Books Ltd v. India Book Distributors Etow (1985) FSR 120*). Even patents do not offer this protection against parallel imports (Knight, 1990]).

However, the 1984 Copyright Amendment Act contains provisions where the transmission of a computer program by delivery downline to an operable copy locally is a offence for distribution but is not debarred as a means for importation. Thus, if the blurring of data and program that has been asserted earlier is accepted as opening a basis for contention, then the operation of **and the down loading of data from** online data bases held overseas would not be debarred either. However the transmission of visual images and sounds are specifically covered- and other materials (in a narrow interpretation) are not (Ricketson, 1990).

This adds to the grounds to support (Knight, 1990) in his plea that 'reproduction' itself become the subject of a new amendment to the Copyright Act.

D.4 DATABASES AS A SPECIFIC OBJECT OF COPYRIGHT

The question of database protection now requires a separate line of attack: the machine readability issues have already been addressed, but the application of Copyright Law to facts is now the issue. The basic legal question of this type remaining is the applicability or otherwise of a level of originality in the 'work'.

To this extent the machine readability and related matters are of lesser concern, and the independent argument of the nature of the facts and their arrangement is at issue. Ricketson (1990) argues that there are two types of question to be resolved: the storage, use and

protection of works already Copyrighted which are stored in a database, and secondly the protection of the databases themselves (which may or may not contain material already subject to Copyright).

The 1985 Japanese Copyright Act (an amendment of the Japanese Law 48 of 1970) provides copyright protection to databases irrespective of their containing copyrighted material, and was based on a modification of existing Copyright law as a result of pressure from the EEC (Commission of the European Communities, 1988) not to create a special form of legal protection for software .

Bibliographic data restricted to titles only presents no difficulties, indices of material of increasing content arguably can become copyrightable (Brown, 1985) but once an abstract is appended in the database then copyright clearly obtains for the author of each entry (*Valcarenghi v. Gramophone Company Ltd (1928-35) MacG Cop Cas 301],* and could also apply to the total collection.

In electronic terms, the Australia Copyright Amendment Act of 1984 was an early and prompt entry into the efforts to clarify the law in this area, but it is necessary to refer to the speech by the Federal Attorney-General at the introduction of the Bill (Commonwealth of Australia Parliamentary Debates V s.10.4 2422 4.6.84) to clarify the intent that "*...a work can be made by simply depressing the keys required for entry into a computer*"

D.5 AUTHORSHIP OF DATABASES

As a further problem in current local and international copyright legislation, s.32 of the Copyright Act 1968 (CAL.) requires that author of a work must be a natural person and thus excludes a computer program or the cumbrous handling of a continually updated data base. The French practice is to recognise the ownership of Copyright of *oeuvres collectives* such as dictionaries and encyclopaedias is the natural or legal person in whose name the work is made available to the public (Ulmer, 1976). However satisfactory this might be for the printed work, the question of electronic holdings clearly remains unresolved by this guidance. S.9(3) of the Copyright Act 1988 (UK) is a specific provision to overcome this by designating who should be deemed to be the author of a computer generated work.

The major issue addressed by the Courts to collections of data is the degree of effort or difficulty that has been applied to create the work - which may be interpreted by the Courts as "originality" enough even just for a layout of information (*Ladbroke (Football) Ltd v. William Hill (Football) Ltd [1964] All ER 485 (House of Lords)*). This does not necessarily suffice to establish Copyright, as Latham notes in (*Victoria Park Racing and Recreation Group Pty Ltd v. Taylor [1937] 58 CLR 479*) where it was established that : "*the law of copyright does not operate to give any person an exclusive right to state or describe particular facts*", given in the case of lists of horses and their running status in races.

This provides a lower limit to the level of copyright (if not ownership) of the simpler types of databases. Further, 10(1) of the Copyright Act 1968 (ACL.) expressly covers "*a table or compilation, expressed in words, figures or symbols whether or not in a visible form*" : see also Lahore (1977). However, the very recent Feist case in the US has placed much of the present case law on copyright applied to collations of facts (and *à fortiori* to databases) in doubt.

D.6 COPYING AND REPRODUCTION RIGHTS IN DATABASES

The last stage considered here is the usage, copying and reproduction: all critical aspects of the ownership aspects of copyright. The key problem identified in several Acts is the lack of a full treatment of the term 'reproduction' or 'copy'. The capture of significant amounts of information from a database would be permitted under copyright law, the reproduction of a

machine readable database requires more careful definition than for literary works of a physical work.

The Australian Copyright Act is probably deficient in this area, but the UK 1988 Copyright Act confirms an exclusive reproduction right in any material (*Copyright Designs and Patent Act 1988 (36 Eliz II c48 s.16(1)(a) (1988)*), and the US 1976 Copyright Act (Anon, 1976) provides specifically for machine copying.

Until the Feist case in 1991 in the US, it could have been said that there was a growing consensus on copyright and reproduction rights on computer and other data and databases, in that a modicum of effort or originality would usually be sufficient to ensure that copyright could be secured for a database or compilation of facts. The EEC called for submissions in 1988 specifically on databases and copyright as an urgent issue (Commission of the European Communities, 1988). The outcome forms part of the basis for the currently emergent EEC policy. It is clear that there are many gaps as yet unresolved, yet there are already billion dollar industries based on database access.

If the Uruguay Round of GATT is completed, some of these ambiguities will be resolved, as the TRIPS protocols (GATT Secretariat, 1992) specifically state that "*Compilations of data or other material, whether in machine readable or other form, which by reason of the selection or arrangement of their contents constitute intellectual creations shall be protected as such. Such protection, which shall not extend to the data or material itself, shall be without prejudice to any copyright subsisting in the data or material itself*" (Article 10.2).

The special roles of the public sector in the access and licensing of public sector data collections and statute law and regulation and the privacy aspects considered in each domain need to be reassessed in the light of the emerging legal position.

D.7 PRICING PROVISIONS

Where a contestable market for spatial data supply exists is where the information may be recreated by third parties and supplied in competition with other providers. There are two bases for such market entrants to compete: Price and Quality.

The monopoly position of some current providers is buttressed by the Government Copyright of public information (something that the US specifically abjures, to the great stimulation of added-value enterprise in America). Recent developments in NSW have at long last placed the text of the law in the public domain (McGuinness, 1993), but no such position has yet been mooted by public sector data holders who, in the main, hold both legal compulsion and monopoly supply as their basis for market power.

The pricing structures so far developed for spatial data vary widely, but there has as yet been (probably due to the protected position of suppliers such as the ABS) no stratified market for data as it ages, and only a limited segmentation of the market into educational and non educational users. The other major asset of spatial data sources is regular and reliable updating. This too has not yet been pricing into the market, and will probably have to await competition or at least real contestability.

It would be valuable to conduct the debate on the basis of the low marginal cost of data provision in bulk format (CD Rom costs are comparable to the stamps required to mail them). The fact that public sector data providers have major operational or statutory responsibilities which require them to collect data (and justify the legal compulsion applied) in the public interest.

Any charging structure beyond marginal costing should therefore attract close examination for lack of competition or abuse of market power. The massive - and still growing - impact of information technology and telecommunications on intellectual property is making the

enforcement and maintenance of monopoly rents in computer-based information less and less easy to manage.

Oniki (1992) points out that as information is a public good, the social and private benefits will be the greater the more widely it is copied and used. Oniki (*op. cit.*) developed an economic model of intellectual property information costs and benefits, and suggests that the economic balance is struck at recovery of the cost of production of the information.

This model corresponds well with the US Government approach to government funded information, where it is freely available at no charge or at the cost of distribution (as the information has been collected for Government purposes, and has thus been taken to have liquidated the production costs).

D.8 QUALITY FACTORS

Base data quality can be judged by cross-comparison between different sources of information for the specified region: for spatial information may be a range of cartographic and remote sensing information sources, and for vectorised features may require the reconciliation of survey and organisation-specific permanent reference points. Administrative boundaries are in a special category, as there is a basic specification for each that is taken to define the boundaries, and reference back to this resource is necessary to confirm the accuracy of its creation in a machine readable format. Quality is therefore likely to be a different measure for each type of dataset.

For example, vectorised files permit transport and other networks to be handled in a GIS context rather than simply on a network connectivity basis (as most transportation models do). The levels of resolution offered sets defined limits on some of the applications, and the requirement of a land information system would not be expected to coincide with the needs of a road authority wishing to use dynamic segmentation to construct a Pavement Management System on the basis of their road network database.

Quality in one case would be the accuracy of the spatial data points, while in the second it would be the accuracy and currency of the data associated with each segment of road, as the spatial accuracy (for this purpose) is not the central issue. There are numerous applications for spatial information data and GIS in transportation. These range from improving the survey sampling frames to accelerating the development of models and network forecasts and the location of facilities in response to socio-demographic and marketing analysis.

One of the key applications is for vehicle location. This requires only a low level of accuracy in terms of spatial precision (10m) but a high degree of accuracy in terms of timing. Increasingly the applications of spatial data sets will use a range of different 'quality' descriptors, and a tiered market will develop as entrants succeed in breaking into the market.

Appendix E

Urban Transport Planning Software

Appendix F

A Synthesis of Transport Panels

TRANSPORT PANELS	AUTHORS	MODELS AND APPLICATIONS
Dimensions of Automobile Demand Panel A 4 wave annual panel (1981-85) of 1172 households in Sydney.	• Hensher *et al* (1991)	• Used static and dynamic discrete and continuous choice econometric models to look at the household sector's demand for automobiles.
The Dutch National Mobility Panel Ongoing panel with 6 monthly waves begun in 1984, though waves less frequent now.	• van Wissen and Meurs (1989) • Goodwin (1989) • Kitamura and Bunch (1989) • Kitamura (1987)	
		• An overview of the history and research experiences of the panel. • Effects of lifecycle changes on public transport use were looked at in a hypothesis testing environment (no modelling). • Ordered response probit models were used to test state dependence and heterogeneity in household car ownership. • Discrete choice (ordered response probit) model of car ownership to investigate the relationship between car ownership and travel behaviour.

TRANSPORT PANELS	AUTHORS	MODELS AND APPLICATIONS
The Cardiff Consumer Panel 24 week panel of 454 households recording daily food and grocery shopping, including travel to and from shops.	• Wrigley *et al* (1984) • Wrigley and Dunn (1984a, b, c and 1985) • Guy *et al* (1983)	• Negative Binomial Distribution and other stochastic panel data models were used to look at the broad spectrum of shopping behaviour in Cardiff.
Michigan Panel Study of Income Dynamics Five thousand American families were followed from 1968 on a yearly basis in order to interpret trends in family well-being.	• Morgan *et al* (1974) • Börsch-Supan (1987, 1990)	• Outline of purposes of panel study. • Identifying various economic and demographic mechanisms underlying household choice behaviour with a conditional fixed effect multinomial logit model.
Honolulu Staggered Working Hours Demonstration Project Commuting experiences of 2000 downtown employees on each of 4 days, two weeks apart, for two days before and two days after the demonstration project.	• Giuliano and Golob (1990) • Golob and Golob (1989)	• A conditional fixed effects multinomial logit model was used to determine and explain time savings or losses for different commuters.

TRANSPORT PANELS	AUTHORS	MODELS AND APPLICATIONS
State of California Telecommuting Pilot Project 2 wave travel diary survey (1988 and 1989) of 217 state employees was conducted to determine the effect of telecommuting on household travel behaviour.	• Pendyala, Goulias and Kitamura (1991)	• A spatial and temporal analysis using geocoded trip data was used to determine impacts of telecommuting on household travel behaviour. Crosstabulation and spatial mapping were the main forms of data presentation.
Teleworking in the Netherlands A five wave panel of 30 workers in the Ministry of Transport at 3 month intervals during 1990 and 1991 to assess the impact of Teleworking on travel behaviour.	• Hamer, Kroes and Oostroom	• Simple crosstabulations, comparisons with the actual population and time series graphs were used, with pairwise t-tests used for significance testing.
San Diego HOV Panel Study Looks at impact of reversible car pool lane.	• Supernak and Kitamura (1989)	
London Regional Transport Panel 8 wave panel with 6 month periods (1982-1985). 2000 people per wave, but for a matched sample, only 400-700 per wave for continuous observation of travel behaviour.	• Terzis (1988) • Stokes and Goodwin (1988a)	• Variability indicators and measures of continuity between matched pairs over time were used. to examine how travel behaviour and use of public transport modes vary over time.
NDP-Autofacts Gasoline Panel Survey Six and a half year panel (1978-1984) of almost 7500 households using a monthly mail in dairy.	• Gilbert (1992)	• Duration model used instead of usual discrete choice models to better capture the dynamics of automobile ownership decisions.

TRANSPORT PANELS	AUTHORS	MODELS AND APPLICATIONS
The Puget Sound Transportation Panel A general purpose urban travel survey panel begun in 1989 and is ongoing with 2 waves per year presently. Involves travel diaries similar to Dutch panel in one half year, and attitudes/values in the next..	• Murakami and Watterson (1990)	• Description of panel exercise, no data analysis.
RBL-Forecasts Motorists' Diary Panel Continuous purchasing panel based on 4000 motorists using a monthly diary of petrol and other motoring accessories (1964 →).	• Johnson and Cornell (1982)	• Simple frequencies were used to determine companies market share, the success of self-serve etc., while the fitting of a logistics curve was used to predict future trends.
The Greater Manchester Passenger Transport Executive Panel Four surveys of individuals at six monthly intervals (1986-7) using one week travel diaries. Approximately 1000 respondents per wave.	• Pickup *et al* (1991) • Goodwin (1988) • Meadowcroft (1988)	• Hypothesis testing with various statistical techniques such as correlation coefficients was used for three panel data sets to investigate the people who lower their level of car ownership and why they do.
South Yorkshire Panel 11 year, 5 wave (ongoing) panel (1981,4,6,8 and 1991) using one day travel diary to investigate the effects of transport policy changes on travel behaviour.	• Goodwin (1988) • Stokes and Goodwin (1988b) • Stokes (1989)	• As for Greater Manchester Panel. • Variables compared over time visually via graphs of frequency counts. • Simple graphical presentation of frequency counts.
Banbury Panel—Oxfordshire Activity-travel diaries carried out in 1976 and 1982 of the same 100 households Unplanned, dwelling based panel).	• Goodwin, Dix and Layzell (1987)	• Graphed relationship between age, license holding and household moving.

TRANSPORT PANELS	AUTHORS	MODELS AND APPLICATIONS
LA (CalTrans) Continuous Observation of Public Transport Demand	• Golob and Golob (1989)	
British Household Panel (just started) Planned to be 10 years of annual surveys of 5000 households.	• Rose *et al* (1992)	• Planned to be an extensive omnibus focusing on socio-political questions and household dynamics. Travel diaries or time budgets are under consideration.
Littlemore Panel 79 respondents recruited from on-bus survey to complete one week travel diary for three years running.	• Stokes (1988)	• A relational data base was set up so as to compare the behaviour of the same individuals without aggregation. Travel time diagrams and activity profiles for different times of the day , and time budgets for different activities used also to look at the effect of bus service changes on travel behaviour.
Sainbury's Swindon Panel 3 waves over 9 months (1990), one pre and two posttests around the opening of a new store. 500 households took part, with one travel diary and grocery shopping diary.	• Stokes and Armstrong (1991)	• Still confidential.

Appendix G

Survey Methodology Issues

G.1 COMPUTER AIDED TELEPHONE INTERVIEWS (CATI)

Activity diaries, Transport Control Measures (TCM) Stated Preference (SP) tasks, and panel surveys lend themselves naturally to collection using computer-aided (or, "assisted") telephone interview (CATI) surveys. The CATI method is important for activity diaries because the interactive and transparent branching allows for the acquisition of:

missing travel and activity sequences (by real-time checking of sequence logic);

recall of travel and activity details unique to each mode or type of activity;

pin-pointing of locations by acquiring data on cross-streets or other landmarks when addresses are unknown.

The CATI method is important for TCM stated preference tasks because:

clarifications and other types of help can be provided to respondents, as in more expensive face-to-face interviews;

the SP designs can be readily customised; and

respondents can specify their own available sets of choice alternatives (sometimes called "consideration sets") without prompting.

Finally, CATI surveys are natural for panels, because data from the previous wave of the survey can be posted on the interviewers screen, and respondents can simply be asked whether or not these previous conditions changed. The complicated branching needed to track all possible changes in household composition, employment status, vehicle fleets, etc. will be transparent to the respondent.

G.2 REDUCING SURVEY BIAS

Surveys are subject to many types of biases, including inaccurate responses from respondents and failure to collect appropriate data. Although panel surveys certainly suffer from the same biases, the fact that panels can collect repeated measures from the same respondents permits the application of powerful statistical techniques to correct for some biases. For example, there may be respondents who consistently under-report their commute times. As long as the extent of the under-reporting is the same over time, panel data will still give accurate measures of changes in commute times.

Panel data can also be used to detect some types of respondent errors that cannot be detected with cross-section surveys. For example, if a respondent reports very different commute

times on consecutive waves of a panel, and if there are no changes in work or residence location, then we can conclude that the reported commute times are suspect.

G.3 REDUCING PANEL ATTRITION

One common problem with panel studies, attrition, occurs when respondents in earlier waves of the study cannot be interviewed in the current wave. If the dropouts are not a purely random sample of the population, then attrition can cause biased inferences from the sample. The problems caused by non-random attrition are similar to those caused by respondents' refusal to participate in a cross-section survey. However, because we have at least one wave of data for the dropouts, it is relatively easy to measure and correct for attrition bias.

Even if attrition is completely random, it will eventually decrease the sample size to unacceptable levels. Therefore all panel studies take steps, such as increased callbacks and cash incentives, to reduce attrition. Long-running panels also need some mechanism to keep the sample representative of the underlying population. The simplest approach is to follow all members (including children) of the original sampled households as they form new households. This allows the panel to mimic the natural process of change in the underlying population. Unless immigrants freely marry members of the existing population, it is also necessary to periodically add samples of recent immigrants to the panel.

G.4 ACCOUNTING FOR SP AND PANEL CONDITIONING

One problem with repeatedly surveying the same sample is that respondents become accustomed to the survey questions and procedures. Although this can speed up the survey process, it can also result in biased responses if respondents learn that changing their answers to key questions can considerably shorten the survey, and if the knowledge gained in prior surveys affects the manner in which they answer questions. The easiest way to avoid this problem, called "conditioning," is to minimise the use of redundant questions across different waves of the panel.

It is also very important to develop a sampling scheme in which there are hold-out sub samples that are not exposed to certain SP tasks and in which there is sample refreshment. Conditioning can then be tested for by comparing the various sub samples.

G.5 SURVEY COSTS

Survey costs for running panel studies are usually no greater than those for comparably-sized cross-section studies. To avoid attrition, most panel studies use increased callbacks and other response incentives. However, these extra costs are balanced by the reduced sampling costs beyond the first wave of the panel. The integration of SP tasks in a single survey will also results in reduced costs compared to stand-alone SP surveys, and SP and RP survey operations can be sequenced in time to reduce expenses associated with interviewing peaking problems.

G.6 SURVEY SAMPLING

G.6.1 Stratification

For maximum survey efficiency and scope and power in modelling and analysis, sampling should stratified. Stratification criteria will depend on desired policy sensitivity, but the following are suggested for general-purpose surveys, in perceived order of priority:

. socio-demographics (including, but not limited to life-cycle strata)
. residential location (e.g. mixed-land use versus suburban neighbourhoods, good versus poor pedestrian or transit accessibility)
. economic and employment status
. vehicle ownership; and
. mode usage.

G.6.2 Panel Components

The initial stage of sample design is similar for panel and cross-section studies; the objective is to obtain a sample that is representative of the underlying population. The best way to do this is with pure random-digit telephone dialling. Once the initial sample has been drawn, it will be necessary to draw additional samples for each wave to compensate for the effects of panel attrition and immigration. These additional samples will not be randomly drawn from the population. They will be heavily stratified towards new immigrants and groups more likely to drop out of the panel. Except for immigration, other natural changes in the target population can be tracked by following and surveying all members of the households in the original sample as they age and form new households. Note that whenever a new household is formed within the panel sample, two sample weights need to be adjusted to keep the panel representative.

G.6.3 Seasonality

One problem with both annual cross-section and annual panel surveys is that they cannot measure potential seasonal changes in commuting behaviour. Since panel data collection is an on-going process, it is relatively easy to stagger the interviewing for a fraction of the sample to measure possible seasonal effects. This may slightly increase survey monitoring costs, but it also allows for smaller (and sometimes cheaper) survey research firms to bid for the survey work.

G.7 DATA PROCESSING AND ANALYSIS

G.7.1 Geographical Information Systems (GIS) Capabilities

Spatial locations of residences, work sites, activity sites, and trip ends is enhanced through the use of a modern geographic information systems (GIS). Many of the problems associated with “traffic analysis zones” and other artificial subdivisions of an urban area and its hinterland can be completely avoided using GIS.

With today’s technology -- CATI surveys, computer networks, GIS, and CD-ROM datasets -- there is no reason why spatial locations cannot be point-located on urban maps. Metropolitan planning commissions and governmental associations in some countries such as the USA have access to address databases for almost all commercial properties and major activity sites and theses addresses are superimposed on complete street network maps. Many of these maps and related databases have been developed in support of emergency management (911) dispatch systems. Most GIS systems have address-matching capabilities that can point-locate residences in the same map systems. And reverse telephone directories are available on CD-ROM that can be used to located residences with listed telephone numbers from that number alone. Survey data can be networked from a CATI survey installation to a GIS installation for geo-locating of respondents in a timely manner. Thus, survey administrators can keep real-time (e.g. overnight) track of the spatial distribution of the survey sample in controlling for survey completion rates for spatial strata.

However, there is a substantial cost in mounting and maintaining GIS capability. This cost is mostly in terms of staff time, as the learning curve for a sophisticated GIS is steep and prolonged. There is also a danger that staff and clients alike will become mesmerised at presentation of data in elegant multi-colour, high resolution graphics to the exclusion of non-spatial data and model results.

G.7.2 Longitudinal Data

Analyses that fully utilise the panel survey's potential will require different resources than are generally spent on analysing cross-sectional surveys. Traditional transport planning consultants, at least those in Australia, the USA and Europe, are not well trained or experienced with dynamic analyses. Many market research and social research consulting firms are well equipped to conduct basic dynamic analysis, but are not aware of the special requirements and opportunities presented by transportation data. Newly constituted teams of academics and consultants might be called for.

G.7.3 Sample Weighting

Multiple imputation, related to the technique of Bootstrapping, is the most general and powerful method for survey weighting. It allows a survey sample to be optimally balanced to several criteria simultaneously. The technique is well developed in the social sciences, and is being used extensively with census data in some countries. Transport survey applications are just emerging, and an examples are the two panels conducted by ITS at the University of California, Irvine.

G.7.4 Stated Preference Data

As with longitudinal data, this is an emerging area in transportation research. What is needed are comprehensive models that combine the SP data with RP choices, so that the SP attributes are true extensions of real world circumstances. The key here is the integration of SP data with static data from activity diaries and detailed household characteristics, and dynamic data from vehicle transactions and changes in travel patterns (RP data). There are estimation methods that are capable of handling joint SP/RP data, but the disaggregate travel demand models most planners are familiar with must be modified before they can handle joint endogenous choice variables.

G.7.5 Micro-Simulation Forecasting

An appropriate forecasting method is one that begins in the base year and marches out period-by-period (say, year by year) by applying incremental changes that have been estimated from the behavioural models. In each period, the changes are based on the new states forecasted in the previous period. This accommodates dynamic models of adaptation and transaction, and also allows reality checks. Such models are common in fields such as sociology and labour-force economics, but are relatively new in transportation planning. A micro-simulation application underway is the California Vehicle Ownership and Use Forecasting Project being conducted through 1995 at the Institutes of Transportation Studies of the University of California, Irvine and Davis.

Appendix H

Recent developments in Traffic Assignment Methods

H.1 INTRODUCTION

Many temporal analyses of peak period traffic flow have been conducted in recent years. The research efforts to date on modelling time varying traffic flow on congested networks have been mainly directed towards developing closed-form analytical models or simulations of small, idealised networks. Dynamic network models have not been extensively developed or implemented. As stated by (Carey 1987):

> *Almost all work to date on the network flows over time has considered only one or two arcs or intersections, has been heuristic, has assumed that the travel time on each arc of the network is independent of the flow rate or volume on the arc, or has used simulation rather than optimisation.*

Two of the earliest works on this topic were produced by Yagar (1971) and Robillard (1974), although their models were very limited in scope. Merchant and Nemhauser (1978a) formulated a nonconvex system-optimal version of the dynamic traffic assignment problem in which there can be multiple origins but only one destination. Merchant and Nemhauser (1978b) and Ho (1980) explored ways of solving that problem, for which a globally optimal solution is rather difficult to obtain. Carey (1986) shows that the Merchant and Nemhauser formulation does satisfy a certain constraint qualification needed for Kuhn-Tucker optimality conditions to exist at the optimum. Carey (1987) presents an alternative formulation of the Merchant and Nemhauser problem with only one destination that is convex and can be made piece wise linear for solution purposes.

H.2 CONTRAM by TRRL

With recognition of the effects of congestion on traffic assignment, the importance of considering the time-varying nature of travel demand, during the peak period, has received much needed attention lately. Literature on dynamic transportation models has been growing. One of the popular dynamic transportation models is CONTRAM which was developed in TRRL by Leonard and et..al (1978). CONTRAM considers demand as a time-varying quantity and assigns the time-varying demand to a detailed road network. It uses a standard traffic assignment principle, i.e. the equilibrium principle, and it relies on time-dependent queuing models for estimating travel times and delays. In estimating travel time, the method in CONTRAM, however does not explicitly take into account those flows which, although entering the network after a given traffic, would affect its progress. CONTRAM uses a

decomposition approach iteratively to update the travel time in order to reduce the effect of this problem.

CONTRAM requires that the time varying distribution of the input origin-destination (OD) trip matrix be predetermined; it does not predict the time varying distribution of a given total OD trip matrix. It cannot simulate the effects of variable work start times on the temporal distribution of demand or on the time-varying flows in the network (Alfa 1986).

H.2 TRIPS by MVA Systematica

TRIPS dynamic assignment captures some major effects such as traffic flow variations over time, intersection interactions, and changes to the demand matrix. Rather than modelling individual vehicles, or packets of vehicles, it retains its representation of vehicles, as values of flow rates (eg. vehicles per hour). These flow rates may vary over time and, to consider this, time is divided into 'Time segments'. This time varying flow rate is expressed as a 'Flow Profile'. In other words, the Flow Profile shows the change in flow rates over a period, typically representing a peak period (Logie 1993).

The pattern of traffic demand over space is given by the user as an OD matrix, and over time as a flow profile for each zone. This flow profile, therefore, expresses information about when people wish to begin their journeys. Dynamic assignment, in effect, moves such demand flow profiles along paths linking origins and destinations. These profiles merge with those of other paths and so provide for each 'arc' (a combination of link and intersection movement) an expressed flow profile.

Dynamic assignment operates within a conventional capacity restraint framework, using the volume averaging approach for obtaining multiple routes. As the profiles move along paths they are subject to influences that distort them. Capacity limitations may reduce the amount of traffic down a path and this causes the flow profile to be flattened by having its peak removed. Trips so removed are stored in a matrix of 'Over Capacity Trips'. The flow profile at the destination of the trip may therefore be quite different from that at the origin. The over-capacity matrix from Dynamic Assignment provides basic information about which part of the demand matrix must change; but whether trips are suppressed, alter their start time, their mode of travel, or their destination requires further analysis by the user. This analysis is not directly addressed by this assignment procedure.

H.3 DYNAMIC ASSIGNMENT

Janson (1991) developed a math programming formulation of the dynamic user-equilibrium assignment problem (DUEA) and described a dynamic traffic assignment procedure that can be applied to large networks to generate approximate solutions. In this approach, DUEA is a temporal generalisation of the static user-equilibrium assignment problem with additional constraints to ensure temporally continuous paths of flow. The full assignment period of several hours is discretised into shorter time intervals of 10-15 minutes each for which trip departure matrices are assumed to be known. The dynamic assignment procedure is not a convergent solution algorithm for DUEA, but is designed instead to produce assignments that approximate the DUEA optimality conditions.

In his later work (Janson and Robles 1993), Janson demonstrates the effects of arrival time costs in Dynamic User-equilibrium Traffic Assignment (DUEA). The timing of commuting trips (particularly home-to-work) is strongly influenced by arrival time preferences, with departure times being a function of arrival time preferences and expected travel times. Since travel time depends on the traffic volumes, both the departure and arrival time for any given trip cannot be independently scheduled. In this approach, both departure time and arrival

times depend on a weighted combination of travel time plus arrival time cost, which vary by origin-destination (O-D) pair, and the exact form of which affects the distribution of trip schedules. The dependence of departure and arrival times on arrival time costs is shown to be a temporal variant of combined distribution and assignment with additional constraints to insure

DUEA as formulated by Janson & Robles is defined as follows:

> Given a zone-to-zone matrix of vehicle trips between each O-D pair over an analysis period of several hours divided into successive time intervals of 1-10 minutes each, and given aggregate cost function for link travel time and trip arrival times, determine each trip's arrival time and the volume of vehicle on each link in each time interval such that, for each pair of O-D zone, no path used by trip with a common arrival time has a higher travel time than any other path for this arrival time and O-D pair. As a result of equal travel time paths, trips that share arrival times and O-D zones also have equal departure times.

The above procedure includes constraints to the first-in first-out order of trips and temporally continuous trip paths but valid specifications of these constraints still require further refinement to be able to use the above method to evaluate the potential of peak spreading incentives such as flexi-time, staggered work hours, etc.

H.4 RISK ASSIGNMENT APPROACH

Uchida and Iida (1993) focuse on travel time as an index of the traffic flow condition and consider the problem of controlling traffic. Traffic congestion, even when it does not occur, affects driver utility. The possibility of its occurrence also increases virtual travel time. For example, a driver who has to arrive at a given destination by a given time departs earlier and takes a time margin (Safety Margin) to cope with travel time variation. The study evaluates the effects of travel time variation on the costs that drivers incur.

The Risk Assignment is formulated in two models:

1. Risk System Optimal Assignment; formulated as a total risk-minimising problem from the standpoint of the traffic manager who wishes to provide a stable and higher standard of traffic service, and which assumes that drivers follow the routes mandated by the manager.

2. Risk User Equilibrium Assignment; which describes drivers' subjective behaviour in the framework of risk analysis, and extends the conventional equal travel time assignment to an equal effective travel time version.

When travel time varies and cannot be predicted exactly, a driver might start early allowing additional time (Safety Margin) to avoid arriving late for the scheduled time to the destination. This longer travel time is called effective travel time:

{Effective Travel Time} = (Scheduled Arrival Time) - (Departure Time)
= (Mean Travel Time) + (Safety Margin)

The effective travel time focuses on the possibility that a trip conflicts with or is adjusted to fit in with other activities under a time budget and drivers' subjective evaluation of the uncertainty in the travel time. Risk Assignment utilises effective travel time instead of mean travel time to produce a realistic assignment, given travel time variation.

Other studies have focused on the importance of schedule delay in attempting to improve traffic assignment. For example, dePalma *et al*. (1990) proposed an assignment that minimises the difference between preferred and actual arrival time and introduced a pseudo-

polynomial algorithm. Chang *et al*. (1989) presented a method for minimising the weighted sum of schedule delay and travel time by using an ordinary system-optimal assignment algorithm along with network graphs. The risk assignment uses a simple cost minimisation criterion, and considers explicitly the effects of travel time variation. Under the scheduled arrival times, effective travel time increases in proportion to travel time variation. Risk assignment evaluates the variations of respective routes' travel time and assigns the traffic so as to minimise time virtually used for travel, which is given as the sum of effective travel time and schedule delay.

Various issues remain to be investigated in relation to this approach. Further work considering perceived travel time distribution and the validity of measuring travel behaviour in conjunction with actual travel time distribution needs to be carried out. The model presently designed, using this approach, needs also to be extended to be applied to more complex road networks.

H.5 QUICK RESPONSE APPROACH

Loudon *et al.* (1988) developed an approach considered as a Quick Response Approach to captures the peak spreading phenomenon using traffic data from Highway corridors.

The research work in the area of peak period traffic flow has clearly demonstrated a consistent pattern of peak-spreading as facilities becomes congested during the three-hour morning and evening peak periods. Loudon developed a regression model where the dependent variable is the ratio of peak-hour traffic to peak 3-hour volume, and the explanatory variable is the peak 3-hour V/C ratio. He used the morning three hour peak period from 6:00 a.m. to 9:00 a.m. and evening peak from 3:00 p.m. to 6:00 p.m.

In this approach the peak-spreading and volume-delay models are applied to each link every time that link speed updating is required in a standard UTPS-based system. The added steps consist of the following:

1. Compute the current link V/C ratio for the three-hour peak period.
2. Apply peak-spreading model to provide the peaking factor: the ratio of one-hour to three-hour volume.
3. Determine peak-hour volume as the product of the peaking factor and the assigned volume.
4. Compute the peak-hour V/C ratio.
5. Apply the volume-delay model to estimate the revised link speed.

This link updating process continues throughout the iterative equilibrium procedure.

The functional form chosen for the model was (fig. H1):

$$P = 1/3 + A\, e^{b(V/C)}$$

where

P = the ratio of peak-hour volume to peak-period (3-hr) volume
V/C = the volume/capacity ratio

Linearising this formula as an ordinary least squares regression equation, gives

$$\ln (P - 1/3) = \ln a + b(V/C)$$

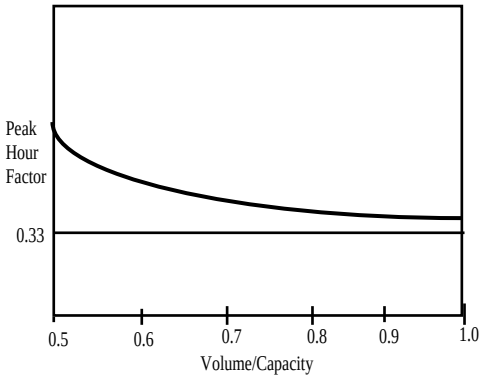

Figure H1 Theoretical relationship between peaking factor and V/C ratio.

The comparison of the above procedure was made to the baseline assignment in which peak-hour volume was 10 percent of the twenty-four-hour volume for 1985 Phoenix data. The improvement in accuracy in the estimation of link volumes was illustrated by the percent error in the overall estimate of vehicle miles of travel (VMT) on the links for which counts were available. The error was reduced from 16.4 to 2.2 percent. The improvement in accuracy in a reduction in the root mean square error (the square root of the sum of the squared difference between observed and estimated speeds on the links) is 35 percent - from 56.0 to 36.6.

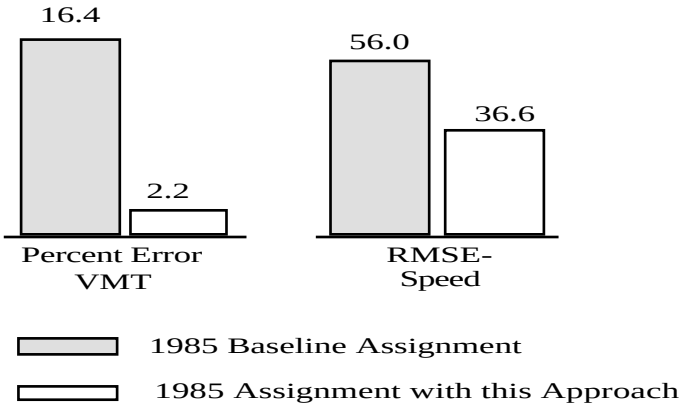

Figure H2 Improvement in Results

An important limitation of the above procedure is that it does not reflect the spreading of the peak outside of a three-hour period. Another limitation is that the model is applied at the link level, while the peak spreading on a specific link may occur as a result of a congestion on some other link in the network. Despite the limitations, the improvement in modelling of the peak hour, the case of Phoenix, were significant. A simple regression model, only needing the traffic count data, makes this approach a perfect quick response technique to capture the peak spreading phenomenon.

REFERENCES

Alfa, A.S. (1986) "*A Review of Models for the Temporal Distribution of Peak Traffic Demand*", Transportation Research, 20(B)(6): 491-499.

Anon. (1976). *Copyright Act Public Law 94-553 Title 17 of the US Code*. US Government.

Axhausen, K.W. (1992) British travel behaviour panels, Department of Civil Engineering, Imperial College, London.

Brown, R. I. (1985). Copyright and computer databases: the case of the bibliographic utility. *Rutgers Computer and Technology Law Journal*, 17.

Carey, M. (1986) "*A Constraint Qualification for a Dynamic Traffic Assignment Model*", Transportation Science, 20(1): 55-58.

Carey, M. (1987) "*Optimal time-varying flows on congested networks*", Operations Research, 35(1): 58-69.

Carson, R., Louviere, J.J. and Hensher, D. A. et al.(1994) Experimental Analysis of Choice, *Marketing Letters.*

Chang, G.L., Mahmassani, H. and Engquist, M.L. (1989) "*System-Optimal Trip Scheduling and Routing in Commuting Network*", Transportation Research Record, 1251: 54-65.

Commission of the European Communities. (1988). *Communication from the Commission Green Paper on Copyright and the challenge of technology Copyright issues requiring immediate attention* (COM(88) 172 final). Commission of the European Communities, Brussels.

dePalma, A., Hansen, P. and Labbe, M. (1990) Commuter's Paths with Penalties for Early or Late Arrival Time, *Transportation Science,* 24: 276-286.

Garfinkle, R. and R. Stallman. (1992). Against software patents. *Communications of the ACM*, 35(1), 17-22,121.

GATT Secretariat (1992). Agreement on trade-related aspects of intellectual property rights, including trade in counterfeit goods (Annex III) GATT.

Gilbert, C.C.M. (1992) A duration model of automobile ownership, *Transportation Research-*B, 26B(2): 97-114.

Giuliano, G. and Golob, T.F. (1990) Staggered work hours for traffic management: a case study, *Transportation Research Record,* 1280: 46-58.

Golob, T.F. and Golob, J.M. (1989) Practical considerations in the development of a transit users panel, *International Conference on Dynamic Travel Behaviour Analysis,* Kyoto.

Goodwin, P.B. (1988) Circumstances in which people reduce car ownership: a comparative analysis of three panel data sets, *Journal of International Association of Traffic and Safety Sciences,* 12(2): 60-65.

Goodwin, P.B. (1989) Family changes and public transport use 1984-1987, *Transportation,* 16(2): 121-154.

Goodwin, P.B., Dix, M.C. and Layzell, A.D. (1987) The case for heterodoxy in longitudinal analysis, *Transportation Research* A, 21A(4/5): 363-376.

Guy, C., Wrigley, N., O'Brien, L. and Hiscocks, G. (1983) The Cardiff Consumer Panel: A Report on the Methodology, Cardiff, Department of Town Planning, University of Wales Institute of Science and Technology.

Hamed, M.M. and Mannering, F.L. (1992) A note on commuters' activity duration and the efficiency of proportional hazards models, *Department of Civil Engineering, University of Washington, Seattle* (mimeo).

Hamer, R., Kroes, E. and van Ootstroom, H. (1991) Teleworking in the Netherlands: an evaluation of changes in travel behaviour, *Transportation,* 18: 365-382.

Hensher, D.A. (1985a) Longitudinal surveys in transport: an assessment, in Ampt, E.S., Richardson, A.J. and Brog, W. (eds.) *New Survey Methods in Transport,* VNU Science Press, Utrecht, 77-98.

Hensher, D.A. (1986) Sequential and Full Information Maximum Likelihood Estimation of a Nested-Logit Model, *Review of Economics and Statistics,* LXVIII (4), 657-667.

Hensher, D.A. (1994) Stated Preference Analysis of Travel Choices: The State of Practice, A *Transportation,* Special Issue on The Practice of Stated Preference Analysis, 21 (2), 107-134.

Hensher, D.A. and Mannering, F.L. (1994) Hazard-Based Duration Models and Their Application to Transportation Analysis, *Transport Reviews,* 14 (1), 63-82.

Hensher, D.A., Smith, N.C., Milthorpe, F.M. and Barnard, P.O. (1992) *Dimensions of Automobile Demand: A Longitudinal Study of Automobile Ownership and Use,* Amsterdam, North Holland.

Ho, J.K. (1980) A Successive Linear Optimisation Approach to the Dynamic Traffic Assignment Problem, *Transportation Science,* 14: 295-310.

Hughes, G. (1991). *Data protection.* Law Book Co and Butterworths, Melbourne.

Janson, B.N. (1991) Dynamic Traffic Assignment for Urban Road Networks, *Transportation Research* 25B(2/3): 143-161.

Janson, B.N. and Robles, J. (1993) Dynamic Traffic Assignment with Arrival Time Costs, *Proceedings of the 12th International Symposium on the Theory of Traffic Flow and Transportation,* Berkeley, California, USA, Elsevier.

Johnson, M. and Cornell, R. (1982) AMOCO (UK's) use of the RBL-forecast motorists' diary panel in petrol marketing, Seminar on the Effective Use of Panels, Lucerne, Switzerland, *European Society for Opinion and Marketing Research*..

Kitamura, R. (1987) A panel analysis of household car ownership and mobility, *Proceeding of Japan Society of Civil Engineers,* 338/IV-7(Infrastructure Planning and Management): 13-37.

Kitamura, R. (1989) A causal analysis of car ownership and transit use, Transportation, 16(2): 155-173.

Knight. (1990). Copyright Act: Copyright in computer software and data in Australia. In G. Hughes (Ed.), *Essays in computer law* (pp. 35-50). Longmans Professional, Melbourne.

Leonard, D.R. and et..al (1978) "*CONTRAM - a traffic assignment model for predicting flows and queues during peak periods*", Transport Road Research Laboratory, LR841,

Logie, M. (1993) Assignment Modelling with Dynamic Traffic Effects, *4th International Conference on Microcomputers in Transportation*., Maryland, USA.

Loudon, W.R., Ruiter, E.R. and Schlappi, M.L. (1988) Predicting Peak-Spreading Under Congested Conditions, *Transportation Research Record*, 1203: 1-9.

Lahore, J. C. (1977). *Intellectual property in Australia* (1st ed.).

Louviere, J.J. and Hensher, D.A. (1983) Using Discrete Choice Models with Experimental Design Data to Forecast Consumer Demand for a Unique Cultural Event, *Journal of Consumer Research,* 10 (3), 348-361.

McFadden, D.L. (1979) Quantitative methods for analysing travel behaviour of individuals: some recent developments, in Hensher, D.A. and Stopher, P.R. (eds.) *Behavioural Travel Modelling*, Croom Helm, London, 279-318.

McGuinnes, P.P. (1993). At last, government legislation is no longer a law unto itself. Australian Sept. 2, 15.

Meadowcroft, S.A. (1988) Passengers and patronage: an analysis of the Greater Manchester Panel Survey, *UTSG Annual Conference,* London.

Merchant, D.K. and Nemhauser, G.L. (1978a) A Model and an Algorithm for the Dynamic Traffic Assignment Problem, *Transportation Science*, 12: 1883-199.

Merchant, D.K. and Nemhauser, G.L. (1978b) Optimality Conditions for a Dynamic Traffic Assignment Model, *Transportation Science*, 12: 200-207.

Monetti, A. (1990). *Copyright protection of electronic databases.* Master of Law Thesis, Melbourne,

Morgan, J.N., Dickinson, K., Dickinson, J., Benus, J. and Duncan, G. (1974) Five Thousand American Families - Patterns of Economic Progress, Ann Abor, Michigan, *Survey Research Centre, Institute for Social Research*, The University of Michigan.

Murakami, E. and Watterson, W.T. (1990) Developing a household travel panel survey for the Puget Sound region, *Transportation Research Record,* 1285: 40-46.

Oniki, H. (1992). Mathematical appendix. In M. Jussawalla (Ed.), *The economics of intellectual property in a world without frontiers: a study of computer software* (pp. 115-135). New York: Greenwood Press.

Paselk, T.A. and Mannering, F.L. (1992) Use of duration models for predicting vehicular delay at U.S./Canadian border crossings, paper for presentation at the 1993 *Annual Transportation Research Board Meeting*, Washington D.C.

Pendyala, R.M., Goulias, K.G. and Kitamura, R. (1991) Impact of telecommuting on spatial and temporal patterns of household travel, *Transportation,* 18: 383-409.

Pickup, L., Stokes, G., Meadowcroft, S., Goodwin, P., Tyson, B. and Kenny, F. (1991) *Bus Deregulation in Metropolitan Areas*, Aldershot, Avebury.

Ricketson, S. (1990). Article on databases. In G. Hughes (Ed.), *Essays on computer law* (pp. 67-98). Longman Professional, Melbourne.

Robillard, P. (1974) Multipath Traffic Assignment With Dynamic Input Flows, *Transportation* Research, 8: 567-573.

Rose, D *et al.* (1991) Micro-social change in Britain: an outline of the role and objectives of the British Household Panel Study, *ESRC Research Centre on Micro-social Change*, University of Essex, Colchester.

Samuelson, P. (1992). Copyright law and electronic compilations of data. *Communications of the ACM*, 35(2), 27-32.

Smith, N.C., Hensher, D.A. and Wrigley, N. (1991) Modelling Discrete Choice Outcome Sequences with Panel Data: An Application to Automobile Transactions, *International Journal of Transport Economics*, XVIII (2), June, 123-150.

Stokes, G. (1988) The Impacts of a Bus Service Change in Littlemore, Oxford in 1984: A Longitudinal Analysis Using Travel Diary Data, Berkshire, Transport and Road Research Laboratory.

Stokes, G. (1989) Bus Users and Car Choosers: An Analysis of the 1988 South Yorkshire Household Travel Survey, *Transport Studies Unit, University of Oxford.*

Stokes, G. and Armstrong, D. (1991) The impact of two new superstores on shopping travel patterns in Swindon: Analysis of a household travel panel travel survey, *Transport Studies Unit, University of Oxford*.

Stokes, G. and Goodwin, P.B. (1988) Instability in the London Transport Market - Preliminary Analysis of the London Panel Survey, 1982-1985, *Transport Studies Unit, University of Oxford*.

Stokes, G. and Goodwin, P.B. (1988) Travel Patterns in South Yorkshire in 1981, 1984 and 1986, Oxford, *Transport Studies Unit, Oxford University*.

Supernak, J.C. and Kitamura, R. (1989) The reversible car pool roadway in San Diego: Perception and reality, *5th World Conference on Transport Research*, Yokohama.

Taylor, M.A.P., Young, W., Wigan, M. and Ogden, K. (1989) *Melbourne Travel Survey Research Project Report No. 1: Overview of Travel Surveys*, report prepared for the MTSRP Steering Committee and the Road Traffic Authority of Victoria, Melbourne, May.

Taylor, M. A. P., Young, W. F., Wigan, M. R., & Ogden, K. W. (1992a). Designing a large-scale travel demand survey: new challenges and new opportunities. *Trans.Res.A*, 26(3), 247-262.

Taylor, M. A. P., Young, W. F., Wigan, M. R., & Ogden, K. W. (1992b). Travel data: their collection and use. In E. S. Ampt, A. J. Richardson, & A. H. Meyberg (Eds.), *Selected readings in transport survey methodology* (pp. 351-371). Melbourne: Eucalyptus Press.

Terzis, G. (1990) Panel analysis: an application to public transport policies in London, *Developments in Dynamic Activity-Based Approaches to Travel Analysis*, Aldershot, Gower, 320-342.

Uchida, T. and Iida, Y. (1993) Risk Assignment: A New Traffic Assignment Model Considering the Risk of Travel Time Variation., *Proceedings of the 12th International Symposium on the Theory of Traffic Flow and Transportation*, Berkeley, California, Elsevier.

Ulmer, E. (1976). *Intellectual property rights and the conflict of laws* . Kluwer, Luxemboug.

US: Bureau of Transportation Statistics. (1993). Transportation Data Sample. Publication BTS-CD-01 (CD Rom in ISO 9660 format)

Wigan, M. R., & Groenhout, R. (1990). How much is it worth to have strategic travel and transport demand information? In *15th Australian Road Research Board Conference*, 6 (pp. 127-146). Darwin, NT: Australian Road Research Board, Vermont, Victoria.

Wigan, M. R. (1985). The secondary use of transport survey data. In E.Ampt, A. J. Richardson, & W. Brog (Eds.), *New survey techniques in transport* (pp. 131-148).

Netherlands: VNU Science Press.

Wigan, M. R. (1990). How do we tie the transport information we need together and deliver it? In *15th Australasian Transport Research Forum,* 2 (pp. 319-330). Sydney:

Wigan, M. R. (1992). Data ownership. In R. Clarke and J. Cameron (Eds.), *Managing information technologies, organisational impact II* . Elsevier/North Holland, Amsterdam

Wigan, M. R. (1993). Establishing issues in transport policy. In K. W. Ogden, E. Russell, & M. R. Wigan (Eds.), *Transport policies for*

the new millennium . Melbourne: Monash University.

van Wissen, L.J.G. and Meurs, H.J. (1989) The Dutch Mobility Panel: experiences and evaluation, *Transportation*, 16(2): 99-119.

Wrigley, N. and Dunn, R. (1984) Stochastic panel-data models of urban shopping behaviour: 1. Purchasing at individual stores in a single city, *Environment and Planning A*, 16: 629-650.

Wrigley, N. and Dunn, R. (1984) Stochastic panel-data models of urban shopping behaviour: 2. Multistore purchasing patterns and the Dirichlet model, *Environment and Planning A*, 16: 759-778.

Wrigley, N. and Dunn, R. (1984) Stochastic panel-data models of urban shopping behaviour: 3. The interaction of store choice and brand choice, *Environment and Planning A*, 16: 1211-1236.

Wrigley, N. and Dunn, R. (1985) Stochastic panel-data models of urban shopping behaviour: 4. Incorporating independent variables into the NBD and Dirichlet models, *Environment and Planning A*, 17: 319-331.

Yagar, S. (1971) Dynamic Traffic Assignment by Individual Path Minimisation and Queueing, *Transportation Research*, 5(5): 176-196.