

loading facilities to ensure that these facilities are being used for their intended purpose. This has been a problem for some time.

The role of urban goods movement, already accounting for one-half of the nation's truck transportation bill, is expected to increase in the decades ahead. The concept of centralized manufacturing has been eroding as small automated plants located near the consuming market are proving to be a more cost-effective alternative to ever-increasing over-the-road transportation and distribution costs. In addition, the concept of zero inventory ("just-in-time") is expected to also increase in popularity in small establishments (manufacturing and retail alike) thereby placing more importance on the movement of decreasing shipment sizes.

The eight examples presented in this paper serve to identify some ideas and options for municipal goods movement project development. Because new goods movement projects are few, evidence of successful and unsuccessful techniques is needed and serves to improve the effectiveness of new projects. It is hoped that this paper satisfies a portion of these information-sharing needs.

REFERENCES

1. P.A. Habib. Practices in Urban Freight. Report UMTA-NY-11-0023-F. UMTA, U.S. Department of Transportation, May 1983.
2. P.A. Habib. Curbside Pickup and Delivery Operations and Arterial Traffic Impacts. Report FHWA/RD-80/020. FHWA, U.S. Department of Transportation, Feb. 1981.
3. Datum Structures Engineering, Inc. Thanksgiving Square Feasibility Report. Department of Public Works, Dallas, Tex., Feb. 1972.
4. A. Ketter. Underground Truck Road--Rochester. Internal Report. Genessee Transportation Council, Rochester, N.Y., 1981.
5. Livingston-Bond Garage. Mayor's Office of Downtown Brooklyn Development, Brooklyn, N.Y., Sept. 1972.
6. Dallas CBD Goods Distribution Project--1979 Update. Internal Report. Office of Transportation Programs, City of Dallas, Tex., July 1979.
7. C.A. Walters. CBD Dallas: A Case Study in Development of Urban Goods Movement Regulations. Proc., Engineering Foundation Conference--Goods Transportation in Urban Areas IV, Easton, Md., June 1981.
8. TEE Consulting Services, Inc. Consolidated Building Receiver Demonstration. Urban Transportation Research Branch, Transport Canada, Jan. 1979.

Publication of this paper sponsored by Committee on Urban Goods Movement.

Directions for Urban Freight Transport Research in Australia

K. W. OGDEN and D. P. BOWYER

ABSTRACT

Some results are reported of a project undertaken to (a) assess the need for further research in freight in Australia, (b) formulate research project statements and identify costs and benefits of such projects, and (c) develop recommendations for further research. The procedures used, which were found to be an effective way of identifying research needs and formulating research priorities and project statements, are documented. The findings of the study are also summarized.

Research in urban freight in Australia has been sustained at a relatively low level in recent years (1). In this sense, it mirrors the situation in North America (2) and Europe (3).

The value of undertaking urban freight research has sometimes been questioned in Australia, as it has in the United States (4). It is sometimes argued that there is little that can be done to influence freight activities, that there is no political or public pressure to tackle freight issues, and that there are few international precedents indicating

"successful" freight research. The essential point that these arguments reflect is that there is uncertainty about the value of further freight research.

In the recognition that such uncertainty exists, the Australian Road Research Board (ARRB), together with the Transport Group in the Department of Civil Engineering at Monash University, recently conducted a study with the broad aim of assessing the desirability of further road freight transport system research and the likely payoffs from such research. The specific aims of this study were to

- Assess the need for further research to satisfy information requirements in the road freight transport field,
- Formulate research project statements and identify the nature and order of costs and benefits for particular research projects and programs, and
- Develop recommendations for ARRB involvement in further road freight transport research.

The scope of the study and the level of investigation were constrained in two important ways. First, it applied primarily to road freight transport, although the interface of road with other modes was also considered. Second, it applied to transport system research. The road technology side, which includes the design of pavements, structures, or vehicles, was considered outside the scope of the study.

This paper is oriented toward research in urban freight because the major research needs identified in the project related to urban problems. The only significant exception to this was intercity truck mass and dimension limits. In this way too the study and its findings reflect the U.S. situation, where, notwithstanding a concern for truck mass and dimension limits (5) and for statewide freight planning (6), the primary concerns in freight planning and research appear to be found in urban areas. The output of the present study should thus be of relevance and interest to a wider audience, in terms not only of research methodology (in which there were some fairly novel features) but also in terms of research findings.

INVESTIGATIVE PROCEDURE

Given the wide scope of the project and its broad objectives, it was necessary to develop a research methodology that would ensure that a broad range of inputs could be accommodated. The methodology also had to be compatible with ARRB's committee process (7) because eventually the research findings had to be processed and ranked by priority within this process. It was not considered appropriate to use this committee process in the usual way because, although it includes open forums (to allow discussion on selected research topics) and executive committees (to formulate recommendations on priorities), past experience has shown it is difficult to identify priorities and appropriate levels of research effort in the urban freight field using this process. The reason for this is thought to be that the relatively open-ended nature of freight research, the absence of precedents, and the lack of an ongoing research program have prevented the emergence of a clear consensus on freight priorities.

In the light of this experience, it was believed that the established procedures needed to be complemented by a more comprehensive investigation of freight transport issues and research needs. This project was initiated to undertake that investigation.

Delphi techniques are one means of identifying issues, developing understanding on a subject, and determining a consensus position about future actions. There have been several reported uses of them in the transport field in Australia (8,9). Consideration was given to using Delphi techniques in this study, and they were seen to be a suitable systematic process for developing understanding about freight transport issues and research needs. However, the resources available to the study were not sufficient to enable the effective use of a full Delphi analysis. An investigative procedure, which

might be considered "partial Delphi," was adopted. It comprised the following primary stages and tasks:

- Stage 1. Develop a statement of issues and research needs. This was based on a literature review.
- Stage 2. Conduct a series of small discussion sessions. These refined the statement of issues and needs and identified research topics.
- Stage 3. Draft research proposals. These address the research topics that are of common interest in the road transport sector.
- Stage 4. Conduct a workshop. The task of the workshop was to consider the draft proposals and possible priorities with the aim of developing positive recommendations for further research. This provided input to the executive committees.

In the balance of this paper each of these tasks and the output from them are described.

IDENTIFYING ISSUES AND RESEARCH NEEDS

Investigative Framework

A preliminary though comprehensive review of Australian freight transport research was conducted as a means of focusing on issues of current concern (1). This revealed that freight research was being undertaken in several broad subject areas, but such a review in itself could not tell much about the current issues and emerging research priorities.

It was thus considered that a systematic investigative framework, based essentially on identifying issues in relation to freight transport objectives, was necessary to aid identification of research needs.

The investigative framework recognizes three distinct, though related, components of freight research:

1. Freight issues that are related to the objectives and constraints of the freight system.
2. Actions that may be taken to resolve one or more of the issues. These may be thought of as broad policy options (e.g., regulation) or specific schemes (e.g., traffic management).
3. Research tasks that are needed to either investigate the issue or appraise the application of action in response to an issue or issues.

These three components are related but quite distinct, and the challenge is to determine how research can be applied either to an issue or to assessing possible actions in relation to it. Their relationship is shown in Figure 1 in which X is the appropriate research project to appraise the effect of action P on issue A. Without loss of generality, X may also be considered an analysis of issue A, or an appraisal of action P, without any cross reference between A and P being involved.

Objectives and Constraints

The desirable starting point for any consideration of freight transport research is the identification of the objectives that the freight system is intended to serve and the constraints on the system.

This immediately raised the question of "whose objectives?" because the objectives of different participants in the freight process will be different and in many cases will be in conflict with those of other participants. Without being flippant, it may be said that the analysis of the objectives

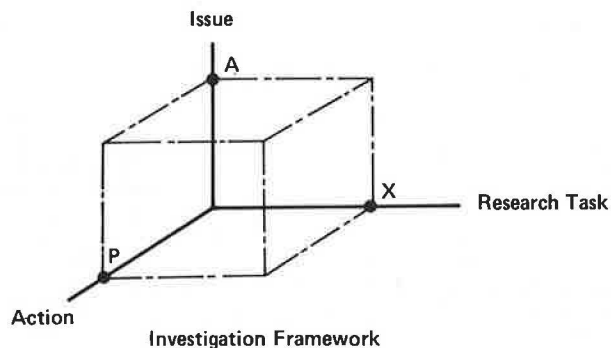


FIGURE 1 Investigative framework.

of these participants could be a major research activity in itself. However, for the purposes of this study, it was assumed that the primary viewpoint would be that of government (given ARRB's interest groups).

Objectives are not always set down or made explicit by government. They can nevertheless be identified by implication, by examining such aspects as resource allocation or areas where policy formulation is occurring. Objectives may be complemented by constraints (e.g., objectives that involve the operational efficiency of the freight sector are of importance because there are constraints on national resource allocations to freight, in terms of such things as investment and energy).

A number of primary objectives and constraints relevant to freight transport in Australia were identified on the basis of the literature, a priori reasoning, and preliminary discussion. The objectives can be broadly stated as

- Service quality. The freight system should meet the freight needs (forms and standards of service) of the community, now and in the future.

- Economic efficiency. Freight is a derived demand, and thus the requisite level of freight service should be provided for a minimum level of resource input.

- Environmental and safety impacts. The detrimental effects of the freight system on the natural and human environment should be minimized.

- Distributional effects. The freight system should feature an acceptable balance between societal and commercial (private) benefits and costs, and it should not hinder (and where possible should contribute to) national and regional development.

- Cost recovery. The taxes and charges paid by the freight sector to government should meet required levels of recovery of public costs (especially infrastructure costs).

- Energy. Appropriate energy resources should be supplied to the freight transport sector and these should be efficiently used within the sector.

Possible Actions

Governments have available a range of possible actions that can be taken in pursuit of these objectives or to satisfy the constraints (3,10). These options include

- Regulation of the industry structure, of the activities of the industry, of the driver, of the vehicle, of vehicle use, and of land use;
- Subsidy and taxation;
- Traffic management;
- Infrastructure for investment and maintenance;

- Training and education;
- Consultative mechanisms;
- Public ownership or divestment;
- Demonstration projects; and
- Technology and design (especially vehicles, pavements, and structures).

Research Tasks

As shown in Figure 1, research may be directed either at specific issues (which arise in relation to the objectives and constraints) or at particular actions (i.e., the application of particular schemes or policy options to those issues). The following list is considered indicative of the sorts of research that might be necessary to assist in the resolution of particular issues or to appraise particular actions that have been taken in practice.

- Development of analytical techniques: supply models, demand models, and impact models;
- Costing analysis;
- Development of information bases and monitoring techniques;
- Basic or exploratory investigation (i.e., assessment of the nature of an issue and its importance);
- Market research, especially in the commercial sector; and
- Development of general procedures methodology for planning, evaluation, impact assessment, and forecasting.

Determination of the appropriate research tasks and specification of the research method were major tasks in the research proposal development stage.

Statement of Issues and Research Needs

Using the investigative framework outlined previously, a discussion note was prepared that included details of the framework itself and statements that represented an initial attempt to define current freight transport issues and research needs. To facilitate the conduct of discussion sessions, this initial set of issues and needs was related to the objectives:

- Service quality,
- Economic efficiency,
- Environmental and safety impacts,
- Distributional effects,
- Cost recovery, and
- Energy.

RESEARCH TOPICS

Process

The statement of current issues and research needs constituted a working document to assist in the process of determining the perceptions of others in the freight transport field on issues and research needs. It specified relevant research topics and indicated the nature of possible payoffs.

To facilitate this process, a series of discussion sessions was arranged, in which the authors led a loosely structured discussion on the general topic of freight research. The discussion note was circulated ahead of time to stimulate response and to guide discussion.

Discussion sessions were conducted with persons from several Australian state road authorities,

state and federal government transport agencies, and railway systems and with particular individuals with knowledge and expertise in the freight transport field.

It is of interest to note that, although in many cases the views of persons involved in the discussions were "predictable" given their affiliation, this was by no means universally so. In some sessions opinions varied significantly among individuals from the same organization, reflecting the varying perspectives on freight issues and research needs within an organization. This experience demonstrates the value of the discussion sessions in bringing to light different perspectives and opinions in a professional environment in which most individuals can feel free to express personal views, not necessarily "organizational" views.

Freight Transport Issues

A primary outcome of the discussion sessions was a clearer statement of current freight transport issues and their relationship to the broad transport objectives outlined previously. These are summarized hereafter. To emphasize the commonality of these issues among industrialized countries (11), recent research elsewhere is cited. No priority ranking is implied.

Service Quality

Three specific issues relating to service quality were identified:

1. Performance criteria and standards. It is generally recognized that the requirements from the freight transport system vary across user segments and thus the importance of particular performance criteria varies across segments. Three such criteria are price, service frequency, and reliability of time of delivery. These criteria also have importance for road infrastructure and urban structure planning because they could influence the amount of travel and the value placed on travel time. However, little hard information exists on either the relative importance of criteria or their inferences for road planning (12-15).

2. Industry structure and viability. The ability of the industry to deliver a desired service is influenced by its structure, as is its ability to conform with community expectations relating to such factors as safety, environmental protection, and cost recovery. Just as the freight market comprises numerous submarkets, so the freight sector is characterized by specialized activities and functions (e.g., forwarders, line-haul operators, local delivery firms, owner drivers, loading agents, own-account carriers). It is a necessary prerequisite to informed policy and planning for freight that the role and contribution of each sector of the industry (and indeed of the industry as a whole) be known and understood. Moreover, because freight movements can be a good indicator of wider economic performance, more attention to monitoring the freight sector could have wider benefits (2,16,17).

3. The freight task. An increased understanding of the size and patterns of freight movement, and of the factors affecting demand, is necessary to aid transport planning. Also, there are major deficiencies in current techniques for modeling the generation and flow of commodities and vehicles, modal split analysis, and freight forecasting (3,18-24).

Economic Efficiency

Four specific issues were identified:

1. Economic growth. Although it is known that transport costs are a significant component of the costs of production, it is not known whether savings in these costs would contribute to economic growth (i.e., the extent to which such savings are really transfer payments). This is particularly significant in that improving "efficiency" might lead only to a growth in unemployment. This does not negate the importance of efficiency objectives (especially where export traffic is concerned), but it does emphasize the importance of considering distribution effects (25).

2. Industry productivity. Transport costs are part of the costs that affect final prices of commodities. Their significance varies considerably from item to item. There is little comprehensive Australian data that would show how important physical distribution management (pdm) costs are in relation to other costs of production, nor of transport costs within pdm costs (26,27).

3. Urban transport network effects. That urban traffic congestion, terminal delays, and certain restrictive operating practices affect freight costs is axiomatic. What is not understood, however, is the effect that these costs have on such aspects as truck productivity (e.g., number of deliveries per day); viability of industry in the locality; and choice of mode or form of operation, including own-account operation (18,21,28,29).

4. Freight system efficiency. A periodic review of the suitability of the various industry parameters (e.g., vehicle mass and dimension limits) and related investment needs should be undertaken. Technological advances in road and vehicle design, or changes in the relative importance of production factors (e.g., labor, energy) mean that a revised set of conditions may be "optimum" (5,30).

Environment and Safety

In this case, four issues were thought to be important:

1. Significance of truck-related road safety. Although trucks are involved in some 15 percent of accidents in Australia involving fatalities, they are overrepresented relative to vehicle-kilometers of travel, and most fatalities are not participants in the road freight industry. There is some research activity on truck-related safety issues at present, but it would probably be true to say that these issues have not been pursued as vigorously as other aspects of safety research. Thus there is a need for improved understanding of the nature of the truck accident problem (17,31,32).

2. Development of truck accident countermeasures. This issue follows from the first; the difference is that this one is focused on development of countermeasures as a follow-on from the analysis conducted of accident patterns.

3. Noise, emissions, and vibration. These three environmental issues probably represent the three most noticeable forms of environmental problems associated with trucks, and, in each case, trucks are significant (or are perceived to be significant) contributors to the overall problem (26).

4. Intrusion into residential streets. Concerns related to the intrusion of extraneous vehicles in residential street networks have come into promi-

nence in Australia in recent years and in some cases trucks figure in those concerns. A range of measures to tackle traffic intrusion has been developed, but it is probably fair to say that trucks have not been treated as comprehensively as cars in these developments. Three aspects are involved: first, the development of means of keeping extraneous trucks out of residential neighborhoods; second, how best to cater for trucks that have legitimate business in the area; and, third, the problem of truck parking (33-35).

Distributional Effects

The two current issues of concern in relation to this objective were

1. Equity: beneficiaries of subsidies. Within the objective that the freight system should provide an acceptable balance between societal and private benefits, an issue of current concern is that of who benefits from existing freight subsidies. The presence of rail deficits and, perhaps, less-than-full road cost recovery implies subsidies, and it is not known to whom these subsidies are benefits, or what the social and economic effects of these subsidies might be (17,26).

2. Regional development. The issue here is the extent to which the availability and quality of freight services within a region (including a metropolitan region) contribute to the amount and location of economic growth, and rearrangement of the location of a given level of growth by transport system attributes (36-38).

Road Freight Cost Recovery

The primary issue was the contribution of heavy vehicles. It was generally agreed that the marketplace is the best determinant of mode use provided that the correct signals on true costs are transmitted to the market. If heavy road freight vehicles are not paying their way, the market may receive inappropriate signals. Moreover, governments are concerned, for financial reasons, that such vehicles should pay their full share of costs of infrastructure provision and maintenance. For both of these reasons, road freight cost recovery is important. However, at the moment there is little consensus on whether heavy commercial vehicles "pay their way." There is lack of agreement on both sides of the ledger; on the cost side, concerning the proportion of road costs allocatable to trucks and, on the revenue side, about which taxes should be regarded as "charges" for the use of roads (17,39-41).

Energy Consumption

Two issues were regarded as significant:

1. Energy consumption audit. Knowledge of the fuel consumption patterns in the road freight sector is essential to the formulation of policies relating to energy consumption. Although broad estimates of total fuel consumption by the road freight sector do exist, there is little knowledge of consumption patterns within the sector. That is, the relative contributions of interstate freight, local urban deliveries, and so forth are not known (42).

2. Fuel conservation. Although there is currently no oil crisis, the memory of past "shocks"

remains. Thus strategies for conserving fuel within the freight transport sector and ensuring its availability to this vital sector remain important requirements (43-45).

Research Topics

The second outcome of the discussion sessions was a lengthy list of specific research topics and indications of the areas in which payoffs might accrue from research (these topics are listed in the Appendix). This information provided the basis for formulating specific research proposals.

Research Proposals

The list of research topics (Appendix) was examined critically with a view to the development of specific research proposals. This involved the implied priority ranking of research topics and, in some cases, the amalgamation of two or more related topics into a single research proposal.

The priority ranking of projects reflected the implicit or explicit importance attached to them by the participants in the previous phase, the extent to which they were judged to be capable of producing worthwhile output within an acceptance time and budget, and their potential relevance to ARRB's interest groups (primarily state road and traffic authorities).

In this way, five research proposals were prepared. The aim of each, and the links to the research topics listed in the Appendix, is as follows:

1. Freight system data and information needs. The aim of this project would be to assist the making of decisions relating to road policy development and road planning design and maintenance by establishing the forms and sources of freight transport information appropriate to assist such decision making. This proposal addresses research topics (g), (h) and (i) relating to Service Quality (Appendix).

2. Freight transport in urban road investment. The aim of this project would be to develop techniques to specifically evaluate freight-related benefits in urban road investment decisions. This proposal addresses research topics (b) and (p) relating to Economic Efficiency.

3. Criteria for management of trucks in urban areas. The aim of this project would be to develop guidelines for explicit consideration of trucks in urban traffic management schemes, both to facilitate freight flow and to reduce the adverse environmental impact of trucks. This proposal addresses research topic (k) relating to Economic Efficiency.

4. Heavy vehicle considerations in traffic signal design. The aim of this project would be to refine those parts of the Australian traffic signal design guides that are affected by trucks (in particular, settings for yellow and all-red) and to develop guidelines for the explicit inclusion of truck factors in area traffic control systems. This proposal addresses research topic (k) relating to Economic Efficiency.

5. Audit of cost recovery studies. The aim of this study would be to improve the information base for consideration of financial cost recovery in the transport sector by conducting a technical audit of network studies to establish a benchmark for further research or policy development. This proposal addresses research topic (g) relating to Road Cost Recovery.

RESEARCH RECOMMENDATIONS

The final phase of the project involved conducting a 1-day workshop at the Australian Road Research Centre in Melbourne to critically appraise, refine, and rank in priority order the research proposals. The invitees were, in the main, persons who had participated in the earlier round of discussion sessions, and the workshop provided an opportunity for interaction among people with different backgrounds and perspectives.

The research proposals were refined and modified as a result of the workshop deliberations, and three of the proposals were recommended to the executive committees for inclusion in ARRB's 1984-1985 research program:

- Freight system data and information needs,
- Freight transport in urban road investment, and
- Heavy vehicle considerations in traffic signal design.

The workshop also indicated that the other two proposals and several of the research topics in the Appendix were relevant to other traffic and transport agencies. Liaison with these agencies is continuing with a view to implementation of research to address these topics.

CONCLUSIONS

The primary conclusions of this paper relate to the procedure reported here for developing research priorities in freight transport in Australia. The procedure was found to be effective in that

- It facilitated the identification of a range of specific issues of current concern;
- It provided a mechanism for generating research topics, and based on those, for developing draft research proposals;
- It provided a means of refining these drafts into detailed research proposals;
- It proved to be an effective information exchange among persons from a range of organizations; and
- It served to heighten awareness of the importance of freight issues within transport planning agencies.

A general guideline might also be drawn for use of the procedures for formulating research directions: the effort to conduct a systematic investigation of issues and research needs would appear to be justified when a consensus on research directions in a particular area is proving difficult to attain.

REFERENCES

1. K.W. Ogden. Australian Freight Research: A Review and Future Directions. Civil Engineering Working Paper 83/3. Monash University, Clayton, Victoria, Australia, 1983.
2. G.P. Fisher and A.H. Meyburg, eds. Goods Transportation in Urban Areas. UMTA, U.S. Department of Transportation, 1982.
3. Goods Distribution in Urban Areas. Round Table 61. European Conference of Ministers of Transport, OECD, Paris, France, 1984.
4. G.A. Shunk. Workshop Summary: Long Range Regional Transportation Planning. In TRB Special Report 196: Urban Transportation Planning in the 1980s, TRB, National Research Council, Washington, D.C., 1982.
5. An Investigation of Truck Size and Weight Limits. U.S. Department of Transportation, 1981.
6. F.W. Memmot. Application of Statewide Freight Demand Forecasting Techniques. NCHRP Report 260. TRB, National Research Council, Washington, D.C., 1983.
7. ARRB Committee Structure. Australian Road Research, Vol. 13, No. 4, 1983, pp. 329-331.
8. J.E. Lane. Comparison of Australian Transport Studies: A Delphi Approach. Internal Report AIR 118-2. Australian Road Research Board, Melbourne, Australia, 1976.
9. The Future of Urban Passenger Transport: A Delphi Survey. Occasional Paper 52. Bureau of Transport Economics, Canberra, Australia, 1982.
10. K.W. Ogden. A Framework for Urban Freight Policy Analysis. Transport Planning and Technology, Vol. 8, No. 4, 1984, pp. 253-266.
11. R.A. Staley. Urban Goods Movement Worldwide--An Overview. In Goods Transportation in Urban Areas, G.P. Fisher and A.H. Meyburg, eds, UMTA, U.S. Department of Transportation, 1982, pp. 133-136.
12. T.L. Friesz, R.L. Tobin, and P.T. Harker. Predictive Intercity Freight Network Models: The State of the Art. Transport Research A, Vol. 17A, No. 6, 1983, pp. 409-418.
13. C. Winston. The Demand for Freight Transportation: Models and Applications. Transport Research A, Vol. 17A, No. 6, 1983, pp. 419-428.
14. W. Young, A.J. Richardson, K.W. Ogden, and A.L. Rattray. Road and Rail Mode Choices: Application of an Elimination-by-Aspects Model. In Transportation Research Record 838, TRB, National Research Council, Washington, D.C., 1982, pp. 38-44.
15. E.R. Cadotte and R.A. Robicheaux. Institutional Issues in Urban Freight Consolidation. University of Tennessee, Knoxville, 1976.
16. D.A. Coutts. Deregulation and Trucking Operations: Implications for Urban Goods Movement. In Goods Transportation in Urban Areas, G.P. Fisher and A.H. Meyburg, eds, UMTA, U.S. Department of Transportation, 1982, pp. 405-412.
17. National Road Freight Industry Inquiry. Final Report. Department of Transport, Canberra, Australia, 1984.
18. H. Nakamura, Y. Hayashi, and K. Miyamoto. Land Use-Transportation Analysis System for a Metropolitan Area. In Transportation Research Record 931, TRB, National Research Council, Washington, D.C., 1983, pp. 11-20.
19. F. Southwark. Logistic Demand Models for Urban Goods Movement. In Goods Transportation in Urban Areas, G.P. Fisher and A.N. Meyburg, eds, UMTA, U.S. Department of Transportation, 1982, pp. 189-204.
20. F. Spielberg. The Planner's Role in Urban Goods Movement. In Goods Transportation in Urban Areas, G.P. Fisher and A.H. Meyburg, eds, UMTA, U.S. Department of Transportation, 1982, pp. 215-224.
21. F. Southwark, J.L. Yong, C.S. Griffin, and D. Zavattero. Strategic Motor Freight Planning for Chicago in the Year 2000. In Transportation Research Record 920, TRB, National Research Council, Washington, D.C., 1983, pp. 45-48.
22. H.S. Levinson. Urban Goods Information Needs. In Goods Transportation in Urban Areas, G.P. Fisher and A.H. Meyburg, eds, UMTA, U.S. Department of Transportation, 1982.
23. Framework for Urban Goods Movement Information in Canada. Urban Goods Movement Report TP 1837.

- Transport Canada, Montreal, Quebec, Canada, 1979.
24. Transportation Research Record 889. TRB, National Research Council, Washington, D.C., 1982.
 25. M. Wachs. Social Trends and their Implications for Transportation Planning. In TRB Special Report 196: Urban Transportation Planning in the 1980s, TRB, National Research Council, Washington, D.C., 1982, pp. 39-47.
 26. K.J. Button and A.D. Pearman. The Economics of Urban Freight Transport. McMillan, London, England, 1981.
 27. Economics of Urban Goods Movement. Urban Goods Movement Report TP 2186. Transport Canada, Montreal, Quebec, Canada, 1979.
 28. M.J. Huber. Estimation of Passenger-Car Equivalents of Trucks in Traffic Streams. In Transportation Research Record 869, TRB, National Research Council, Washington, D.C., 1982, pp. 60-70.
 29. Traffic Capacity of Major Routes. Organisation for Economic Cooperation and Development, Paris, France, 1984.
 30. J.R. Stowers, H.S. Cohen, J.H. Sinnott, H. Weinblatt, J.R. Morris, and J. Dizenzo. Federal Truck Size and Weight Study. In Transportation Research Record 920, TRB, National Research Council, Washington, D.C., 1983, pp. 1-12.
 31. Wilbur Smith & Associates. Heavy Commercial Vehicle Speed and Operational Safety Study. Road Safety and Traffic Authority, Melbourne, Australia, 1978.
 32. Foster Committee. Road Haulage Operators Licensing: Report of the Independent Committee of Enquiry. Her Majesty's Stationery Office, London, England, 1978.
 33. E.R. Cadotte, A. Chatterjee, M. Judd, R.A. Robicheaux, and F.J. Wegman. Planning for Urban Goods Movement. University of Tennessee, Knoxville, 1977.
 34. D. Christiansen. Urban Transportation Planning for Goods & Services. FHWA, U.S. Department of Transportation, 1979.
 35. Lorry Management Schemes: Guidelines. Institution of Highway Engineers, London, England, 1981.
 36. D.J. Gent. The Urban Road Network: An Essential Pre-requisite for Efficient Transport. Highways and Transportation, Vol. 31, No. 4, 1984, pp. 30-31.
 37. A. Grandjean and C. Henry. Economic Rationality in the Development of a Motorway Network. Transport Reviews, Vol. 4, No. 2, 1984, pp. 143-158.
 38. R.L. Mackett. The Impact of Transport Policy on the City. Transport and Road Research Laboratory Report SR 821. Transport and Road Research Laboratory, Crowthorne, Berkshire, England, 1984.
 39. Highway Cost Allocation Study: Final Report. U.S. Department of Transportation, 1982.
 40. C. Hendrickson and A. Kane. Cost Allocation by Uniform Traffic Removal--Theoretical Discussion and Example Highway Cost Applications. Transportation Research B, Vol. 17B, No. 4, 1983, pp. 265-274.
 41. B.D. Statter. A Critique of the Federal Highway Cost Allocation Study's Traffic Analysis. Transportation Quarterly, Vol. 38, No. 3, 1984, pp. 345-360.
 42. A.D. Shuster. Fuel Conservation in Urban Goods Distribution. In Goods Transportation in Urban Areas, G.P. Fisher and A.H. Meyburg, eds, UMTA, U.S. Department of Transportation, 1982, pp. 351-370.
 43. L.R. Johnson, R.E. Knorr, C.L. Saricks, and V.B. Mendiratta. Economic Impacts of Petroleum Shortages and Implications for the Freight Transportation Industry. In Transportation Research Record 970, TRB, National Research Council, Washington, D.C., 1982, pp. 48-55.
 44. R.H. Bixby and A.T. Reno. Energy Contingency Planning for Urban Goods Movement. In Goods Transportation in Urban Areas, G.P. Fisher and A.H. Meyburg, eds, UMTA, U.S. Department of Transportation, 1982, pp. 329-350.
 45. Potential Energy Conservation in Urban Commodity Flow. Urban Goods Movement Report TP 1664. Transport Canada, Montreal, Quebec, Canada, 1978.

APPENDIX: IDENTIFIED FREIGHT TRANSPORT RESEARCH TOPICS

Those topics which led to research proposals are indicated by *.

A.I Service Quality

- (a) Relationships between freedom of entry and perceived problems (accidents, overloading, bankruptcies, etc.)
- (b) Effect of a quality licensing system on number of entrants to the industry, price, level of service, safety, etc.
- (c) Effects on the industry, and on users, of "full," "correct" cost recovery [see (e) also]
- (d) Relationships between freight activity and other indicators (including lags and leads)
- (e) Effect of structural economic change on demand for freight
- (f) Historical trends in service quality, interstate and intrastate
- (g) *Identification of freight system data needs
- (h) *Better knowledge of the urban freight task
- (i) *Better knowledge of the rural freight task (flows, axle loads, commodities, etc.)
- (j) Determinants of mode use
- (k) Futures study: role of modes
- (l) Health and stability of segments of the road freight industry

A.II Economic Efficiency

- (a) Resource costs of urban traffic congestion causing delay to trucks
- (b) *Truck benefits and costs in appraisal of urban road investment proposals
- (c) Relative benefits of investment in transport viz-à-viz other sectors
- (d) Case study involving appraisal of upgrading a route (or new route) in an urban corridor
- (e) Resource costs of "poor" nonurban roads
- (f) Benefits and costs of allowing new technology (e.g., doubles, triples)
- (g) Means of funding road maintenance
- (h) Costs of regulatory restrictions, of nonharmful regulations, of limits on use of technology, etc.
- (i) Truck considerations in geometric design (climbing lanes, lane widths, grades, sight distances, etc.)
- (j) Effect of urban network (e.g., truck routes) on truck operations

(k) *Traffic management techniques directed at urban trucks

(l) Efficiency in resource allocations between modes

(m) Efficiency of terminal operations (including modal interchanges)

(n) Analysis of effects of past road freight deregulation

(o) Effects of transport efficiency on economic growth

(p) *Development of methods of incorporating freight considerations in urban transport planning

(q) Benefits and costs of large combination vehicles

A.III Environment and Safety

(a) Relationship between truck, driver, location, environment, and so forth (if accident data permit)

(b) Effect of quality licensing on safety

(c) Feasibility of public truck parks and bans on on-street truck parking

(d) Analysis of culpability in truck-involved accidents

(e) Effects of enforcement (loads, speeds, maintenance, etc.) on accidents

(f) Truck braking (especially LCVs)

(g) Truck noise

A.IV Distributional Effects

(a) Effect of transport system efficiency on level and location of economic activity in a city or region

(b) Effects of freight subsidy, deregulation, etc. on viability and social structure of country towns

A.V Road Freight Cost Recovery

(a) Technical and constitutional feasibility of introducing an NZ-type road user charges system

(b) Equity in road taxes between passenger and freight

(c) Development of an efficient, equitable method of collecting road user charges from trucks

(d) Deterioration of roads under load and overload

(e) Determination of "correct" level of charges for trucks

(f) Technology of road pricing for trucks

(g) *"Audit" of literature and studies on cost recovery

(h) "Social" cost component in roads expenditure

A.VI Energy

(a) Dissemination of energy research results to truck operators, in the form of guidelines, etc.

(b) Contingency planning against sudden energy shortfall

(c) Fuel economy performance of large combination vehicles

Publication of this paper sponsored by Committee on Surface Properties-Vehicle Interaction.