CANADIAN STUDIES OF URBAN GOODS MOVEMENT—A STATUS REPORT

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This paper briefly reviews several current Canadian research projects and then reports in a little more detail on the one with which the authors are most familiar. An interim report is given on the Transportation Development Agency project. This is a long-range, multiphased program, undertaken by the Canadian government, that is aimed at improving the movement of urban goods in Canadian cities. The first two phases of this work were completed in 1972. Phase 1 was essentially a research project in which candidate improvements to the present urban goods movement system were proposed and computer simulation models were developed to test these improvements. As a by-product of this work, a new urban goods classification system was developed in preliminary form. Phase 2 was an extensive field data collection project carried out in the city of Calgary. A third phase is under way. In this phase, the candidate improvements will be tested by using the phase 1 models and the input data generated from phase 2.

•A SUBCOMMITTEE of the Roads and Transportation Association of Canada deals exclusively with the topic of urban goods movements. On this subcommittee are represented all points of view—shippers, truckers, consolidaters, and government at the three levels. The committee has identified a number of potential improvements and established a subgroup to work on each.

One is the provision of consolidated shipping and receiving facilities to serve large buildings or blocks. Work on this is being headed by Carmichael of the Canadian Industrial Traffic League (1). A survey is being made of such facilities.

At the University of Toronto, Hauer has done some work on truck routes in cities. He has analyzed what has happened in this connection throughout Canada (2). He finds the situation to be chaotic and irrational.

The regulation of street space through parking restrictions and various other regulatory measures is being reviewed by employees of the City of Hamilton. They have sent out questionnaires to all larger cities in Canada and have analyzed existing regulations and enforcement. With the cooperation of the Ministry of Transportation and Communications in Ontario, they have done a detailed survey in the City of Hamilton. The results of these two thrusts are being combined at the present time with some analytical work.

At the University of Waterloo, Hutchinson and others have been doing work on generation or demand. They have surveyed approximately 250 industries in the metropolitan Toronto area and have performed regression analyses on the truck trips generated by these industries (3).

THE TRANSPORTATION DEVELOPMENT AGENCY PROJECT

This project is being carried out by N. D. Lea and Associates Ltd. for the Transportation Development Agency, which is a governmental agency dealing specifically with transportation research and development work. This multiphased research project on the subject of urban goods movement is in progress.

Phase 1: Preparatory Modeling

The first phase included identification of candidate improvements, writing computer programs to simulate the benefits that may be gained from operating on these improvements, and running these programs with some readily available data so as to assess what the data requirements are for a more in-depth evaluation.

The first step was to identify candidate improvements. Data shown in Figure 1 identify 13 candidate improvements in summary form. They are identified through some rational analysis, a review of the literature, and discussions with those working on the subject. The first improvement is in shipping and receiving facilities. Second is to improve the operation of these facilities. Third is to improve the location of terminals including consolidation so as to reduce the number of terminals. Each candidate in Figure 1 has been categorized by possible implementing actions: not applicable, possible, or promising. Discussions of each of these candidate improvements have been published (4, 5, 6). Each candidate improvement was investigated in depth to identify the types of changes that must be modeled in order to simulate the changes that might effect some improvement in urban goods movement. One conclusion was that it is important to model the shipping and receiving facilities, which we have called end-point facilities. The model of end-point facilities is the micromodel. The micromodel simulates operations at end points (i.e., geographical or physical points at which loading/unloading or transfer occurs).

The micromodel is a transaction or queuing model (dynamic and probabilistic) written in the GPSS simulation language. It simulates the pickup, delivery, and transfer operations. The inputs required for this model are

1. Type of end point,
2. Amount of legal and illegal parking available,
3. Number of docks,
4. Number of men working at the facility,
5. Size of the yard,
6. Walking distances, and
7. Types of commodities and vehicles that the model can call up to use for that particular facility at that time of day (whether peak or off-peak).

By means of varying input parameters, the model can be used to simulate any combination of building type, land use, area in the city, time of day, and type of facility. In particular, six types of end points are each simulated in a different way by the micromodel.

1. No facility (curbside operation),
2. Laneway without dock,
3. Laneway with dock,
4. Yard only,
5. Off-street dock, and
6. Yard and dock.

During a run of the micromodel for a particular end point, each of the following operations is specified sequentially: A vehicle arrives at the end point. Vehicle type, shipment weight, and the number of pieces are selected. The weight per piece is calculated. It is determined whether the facility, i.e., the dock, is available. If the dock is available, the truck enters; if the dock is full, the truck departs or enters a queue for the dock or looks for on-street parking. If the truck looks for on-street parking, it parks legally or illegally or departs. Once the truck is parked or in dock, the driver goes to the building, requests men or equipment (if required), goes to find agent, waits for agent, processes papers, waits for shipment preparation (if required), and returns to the truck. Loading or unloading or both take place. The truck departs. If the truck was parked illegally on street, third party (such as passenger car) delay time is calculated. These steps have been described for only one truck. However, in the model many trucks are each going through their operations simultaneously.

Two prime outputs are generated by the micromodel. The first is the total time spent by an average truck in performing the end-point operation. Subcomponents of the total, such as loading and unloading time and time to find a receiver and process papers, are also output. The second prime output is the total delay time experienced by passengers (in automobiles and public transit) in those cases where trucks are blocking traffic. Outputs from the micromodel serve as inputs to the macromodel.

Figure 2 shows a sample output from the micromodel. This is in narrative form for ease of interpretation.

The macromodel is a network flow model written in FORTRAN IV (equilibrium network model). It is similar in nature to the TRANSURB model previously used by N. D. Lea and Associates Ltd. in the Canadian urban transport efficiency study (7). Links represent the road system, and nodes represent zonal aggregates of end points. The macromodel calculates times and costs of trucking operations at three levels: over links, within zones, and at end points. Passenger delay time is also accumulated over links and at end points. The major steps in the macromodel are as follows:

1. Characteristics of links, nodes, vehicle types and costs, and O-D distribution tables by commodity are input (O-D distribution of goods is not modeled).
2. Each commodity O-D movement is assigned to one vehicle type.
3. Time and cost to move over each link are calculated for each vehicle type at the free speed.
4. The O-D demand is assigned over the network on the basis of either minimum time or minimum cost.
5. Congestion time and cost are calculated on each link.
6. Flows on congested links are reassigned by using a minimum path spanning tree technique. Only one such interaction is required.

Steps 1 through 6 calculate time and cost over links.

7. Free speed inside each zone is input.
8. Congested speed inside each zone is calculated based on congested speed-free speed ratios of zone incident links.
9. Total number of truck stops inside each zone is input.
10. Average trip distance between stops inside each zone is input.
11. Cost and time between stops are calculated based on the distance, speed, number of stops, and vehicle cost curves.

Steps 7 through 11 calculate time and cost between end points inside zones.

12. The percentage of each end-point type, by zone, is input.
13. Truck arrival rates are input as a function of end-point type and zone.
14. Total number of end points inside each zone is calculated from steps 9, 12, and 13.
15. Number of end points of each type is calculated for each zone.
16. Time and cost at end points are calculated from truck arrival rates, by using output curves from the micromodels, by end-point type and by zone.
17. Zonal (end-point) times and costs are aggregated.

Steps 12 through 17 calculate time and cost at end points.

The special features of the macromodel are that it deals with as many as 100 commodity types and as many as 10 vehicle types. It calculates for each commodity and vehicle type the total time and cost in the system, and it separates the congestion time and the normal time.

Figure 3 shows a sample summary output from the macromodel. In this summary truck results are grouped together, but they may be disaggregated by the 10 types if desired. The summary shows the quantities moved, the costs, and the times. In addition to these costs and times for normal network transport, the summary shows the costs and times for operation of end-point facilities and for vehicles at the end-point facilities. Then, on a zonal basis, intrazonal movements are also calculated so that the macromodel summary adds up the network costs, end-point costs, and zonal costs.

Figure 1. Means of achieving improvements in urban goods movement systems.

CANDIDATE IMPROVEMENTS	POSSIBLE GOVERNMENT ACTIONS										POSSIBLE INDUSTRY ACTIONS			
	BLD	Regulate					Encourage				Industry Cooperation			USER
		CODE	ZONE	CONL	LIC	TAR	TAX	LEG	RES	DEMO	R.D	STD	TAR	
1. Improve Shipping and Receiving Facilities			Possible	Possible			Promising	Possible	Possible	Possible	Possible	Possible	Possible	Possible
2. Improve Shipping and Receiving Facility Operation								Promising			Possible	Possible	Promising	Promising
3. Improve Terminal Location (Excluding Consolidation			Possible					Possible	Promising	Possible	Possible			
4. Improve Terminal Facilities									Possible		Possible			
5. Improve Terminal Facility Operation									Possible		Possible			
6. Consolidate Pickup and Delivery	Possible			Possible	Possible			Possible	Possible	Possible	Possible		Possible	Promising
7. Improve Pickup and Delivery Operations (W/O Consoidation)								Possible	Possible	Possible	Promising			
8. Improve Truck Design							Possible	Possible	Possible		Promising	Possible		Possible
9. Avoid Road Congestion - Operate Off-Peak				Possible		Possible				Possible	Possible		Possible	Possible
10. Other Measures of Reducing Road Congestion	Promising													
11. Rearrange Land Use - Alter Demand	Possible		Promising			Possible	Promising	Possible	Possible	Possible			Possible	
12. Improve Packaging						Possible		Possible	Possible	Possible	Possible	Possible	Promising	Possible
13. New Transport Modes	Possible								Promising	Promising	Possible			

☐ Not Applicable ▒ Possible ▣ Promising

Figure 2. Sample micromodel output.

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Micro Model base run simulation YARD AND DOCK PEAK

        Fields that are blank do not apply to this end point type

                      *** INPUTS ***

    Simulation length -  120 minutes.
    Arrival rate -    8.6 plus or minus    5.0 minutes.
    Number of docks -  3
    Number of men in addition to driver -  4
    Legal parking length -       feet.
    Yard length -  150 feet.
    Illegal parking length -       feet.
    Average walking distance from yard -    75 feet.
    Average walking distance from illegal parking area -    50 feet
    Average walking distance from legal parking area -  100 feet.


                      ***  RESULTS  ***

    End Point Summary:
         There were  13 trucks that arrived.
          13 trucks stopped to load or unload.
           9 trucks completed operations with an average total ti
             trucks parked on the street or yard.
                .0% parked illegally.
          12 trucks entered the facility.

    Common activities:
         The average time looking for an agent was   4.18 minutes
         The average time waiting for a signature was    1.40 minu
         Of the    6 pickups made the average loading time was   6
         The average pickup was 1232 lbs.
         Of the    5 deliveries made the average unloading time wa
         The average delivery was 1356 lbs.

    Dock activity:
         The average total time spent in the dock was  22.06 minu
         The average waiting time in the queue for the dock was
         The maximum length of the queue was    1
         The average time to maneuver was    1.50 minutes.
         An average of   2.96 minutes was spent waiting for men a

    Non-dock activities:
         The average time spent walking was     .00 minutes.
         Illegal parking caused      .0 hours of passenger delay.
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Phase 2: Data Collection

One of the objectives of phase 1 was to identify the data requirements. This was done so that in phase 2 fairly intensive data could be gathered in one particular city with some assurance that the data would be relevant and useful. Thus, during summer 1972, field surveys were conducted in the City of Calgary. Five types of surveys were conducted.

Screen-Line Counts—Screen-line counts gave a measure of traffic flow by the vehicle type. Some results are given in preliminary form in Table 1. Totals do not equal 100 percent because categories with less than 0.1 percent were excluded. A high percentage of pickup truck trips is seen in Calgary because many of the small private operators use their trucks as recreation vehicles.

Cordon Counts—Cordon counts were performed in selected regions to obtain typical zone generation data by commodity category.

Truck Rider Surveys—Truck rider surveys are not normally undertaken because of the difficulties involved (e.g., insurance and cooperation of the operators). However, these were conducted in Calgary with a fair degree of success. These surveys gave special O-D data and detailed observations of performance of particular vehicles.

Interviews With Truckers—The bulk of the O-D information came from trucker interviews, which are a standard form of survey procedure for this type of study.

End-Point Facility Surveys—The end-point facility studies have been undertaken in special limited cases in the past. To our knowledge the Calgary work demonstrated the first widespread use of such studies. More than 300 end points throughout the city were surveyed. An interesting observation in Calgary is that there are many laneways in the city and, because of this, there are very few cases of trucks parking illegally or blocking traffic on city streets. Most use the back entrances accessible from the laneways. Procedures were developed so that all end points within a given laneway could be surveyed in 1 day.

The data generated in Calgary were checked by using edit-check computer programs developed for this purpose and are now in the form that can be analyzed.

Phase 3 Work

As part of phase 3 the Calgary data will first be reduced to provide inputs required by the micromodels and macromodels, finalize the proposed urban goods classification system, modify the logic to the micro and macromodels if required, and possibly develop a demand generation or distribution model or both.

As an interesting by-product of this work a statistical profile of trucking operations in Calgary will be available. It is expected that interesting conclusions can be drawn on the influence of city size on trucking operations. Certain other model inputs will also be generated at this time such as the link-zone system for the city. The candidate improvements will then be tested and recommendations for future government and industry action will be proposed.

URBAN GOODS CLASSIFICATION SYSTEM

Within the urban area thousands of different commodities are moved and practically all by trucks. By defining a truck in terms of body type, wheel and axle configuration, capacity, and special characteristics (e.g., refrigerated), some 100 separate vehicle categories can be distinguished. Clearly, to collect, assemble, analyze, and use information on commodities and vehicle types require an urban goods classification system that has a manageable number of categories.

Such a classification system should identify goods in terms of their transportation requirements. It should also be structured to be useful in modifying or rationalizing the urban goods rate structure as well as streamlining the paper work procedures.

None of the existing commodity codes satisfies these requirements. Present codes such as the STCC used in the United States describe the commodity in terms of what it is and not in terms of its transportation requirements. An experimental classification system was therefore developed during phase 1. Table 2 gives a summary of the second

Figure 3. Sample macromodel output.

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                                     SYSTEM SUMMARY

LINKS (WITHOUT CONGESTION)           TRUCKS      PASSENGER VEHICLES     TOTAL

     TON MILES                      35822.90         4130.69         39953.61
     VEHICLE MILES                  33725.17       293990.75        327715.94
     COST($)                         6981.39        12660.39         19641.88
     TIME(HRS)                       1714.89        13811.97         15526.85

LINKS (WITH CONGESTION)

     TON MILES                      38086.38         4749.96         42836.41
     VEHICLE MILES                  37298.00       335412.75        372710.75
     COST($)                        24521.97        14515.88         39038.07
     TIME(HRS)                       6097.10        63427.69         69524.44


LINK CONGESTION COSTS($)            17540.59         1855.50         19396.19

LINK CONGESTION TIME(HRS)            4382.21        49615.72         53997.59



ENDPOINTS

     NUMBER SERVICED               5650.82
     COST($)                      13520.57
     TIME(HPS)                     3380.16
     PASSENGER DELAY(HRS)         11546.22

ZONAL OPERATIONS

     NUMBER OF DRIVING TRIPS       9921.60
     VEHICLES MILES                9921.60
     COST($)                       2092.83
     TIME(HRS)                      514.98

TOTAL TRUCKING COST($)            40135.37

TOTAL TRUCKING TIME(HRS)           9992.23

TOTAL TRUCK MILES                 47219.60

TOTAL PASSENGER DELAY(HRS)        61161.94
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Table 1. Vehicle types in Calgary.

Truck Configuration	Wheel-Axle Configuration	Body Type: Pickup	Panel	Step-Van	Van[a]	Stake	Tank	Dump	Lowbed-Flatbed	Box-Hopper	Single Purpose	Refrigerated Van	Total
Straight truck	2 axles, 4 wheels	54.5	2.1	1.6	15.0	1.5	—[b]	—[b]			0.5	—[b]	75.2
	2 axles, 6 wheels			0.4	5.5	5.4	0.6	1.7	—[b]		1.7	0.1	15.4
	3 axles				—[b]	0.3	0.1	2.4	—[b]	0.1	1.2	—[b]	4.1
Tractor trailer	3 axles				0.6	0.1	0.1	0.1	0.1	—[b]	—[b]	—[b]	1.0
	4 axles				0.4	0.1	0.2	—[b]	0.3		—[b]	—[b]	1.0
	5 axles				0.6	0.1	0.5	0.2	0.9	—[b]	0.1	—[b]	2.4
	6 or more axles				—[b]		—[b]		—[b]	0.3			0.3
	Double bottom				—[b]		—[b]		—[b]				—[b]
	Total	54.5	2.1	2.0	22.1	7.5	1.5	4.4	1.3	0.4	3.5	0.1	99.4

[a]Includes ½-ton vans in the 2-axle, 4-wheel category.
[b]Less than 0.1 percent.

Table 2. Suggested urban goods classification system.

Category No.	Commodity Group	Examples and Description	Vehicle Type: Body Type	No. of Axles	No. of Wheels
S1	Service vehicle, mobile	Construction foremen's pickup and other such vehicles with commercial license but used to large degree only to transport the driver	Pickup or station wagon	2	4
S2	Service vehicle, special	Plumbers, carpenters, telephone repair truck that must carry both men (including driver) and tools or materials for them to use, usually with special built-in fittings or equipment	Panel, pickup, or van	≥ 2	≥ 4
V1	Pickup and delivery, single commodity (excluding food)	Usually for small packages, such as mail, for local delivery	Usually van or step-van	2	4
V2	Pickup and delivery, one-man, local	Eatons, local cartage, etc., express co.	Usually van or step-van	2	4
V3	Pickup and delivery, two-man, local	Eatons, local cartage, etc., moving van	Van or stake	2	4 or 6
V4	Distance van	Intercity moving van and intercity van cartage	Van on trailer	3, 4, or 5	10 to 18
V5	Food, local	Frequently single commodity, especially name-brand beverage	Usually van	2	4 or 6
V6	Food, distance	Large food trucks, refrigerated or not	Usually van or truck	3, 4, or 5	10 to 18
K1	Building materials, straight	Various building materials	Stake	2	4 or 6
K2	Building materials, trailer	Various building materials, lumber, etc.	Stake, low-bed on flatbed (trailer)		14 to 18
K3	Equipment and other, straight	Machinery, equipment, and all other materials (excluding building materials)	Stake	2	4 or 6
K4	Equipment and other, trailer	Machinery, equipment, and all other materials (excluding building materials)	Stake, low-bed on flatbed (trailer)	5[a]	14 to 18
D1	Common earth	Machinery, equipment, and all other materials (excluding building materials)	Dump	2	6
D2	Common earth, tandem	Machinery, equipment, and all other materials (excluding building materials)	Dump	3	10
D3	Sand, gravel, ore	Processed earth materials	Dump	2	6
D4	Sand, gravel, ore, tandem	Processed earth materials	Dump	3	10
P1	Petroleum, straight	Gasoline, fuel oil, etc.	Tank	12[a]	6[a]
P2	Petroleum, trailer	Gasoline, fuel oil, etc.	Tank	5[a]	18[a]
P3	Special transport, straight	Livestock, garbage, concrete	Special	2 or 3	
P4	Special transport, trailer	Motor vehicle carriers, cement hopper, container carrier	Special	5[a]	
P5	Special equipment	Snowplows, road maintenance machinery, military vehicles, wrecker	Special	2 to 5	
P6	Mobile home		Special		
W1	Manually propelled	Bicycles, horse- or man-drawn vehicles	Various		
W2	Miniature and motorcycle	Motorcycles, scooters, etc.	Various		
W3	Unclassified straight		Various		
W4	Unclassified trailer		Various		

[a]Usually.

edition of this system. It should be noted that this proposed system has been specifically tailored for the study of goods movement in North American urban areas. That is, it is aimed at testing candidate improvements by using the URBGDS package. It is not necessarily well suited for intercity transport studies. As part of the phase 2 data collection, survey questions were designed so that the preliminary system given in Table 2 could be finalized.

At first glance, this may look more like a vehicle classification system than a goods classification system. This is because we have found that the most practical way of relating goods to their transport characteristics is to identify the vehicle in which they would likely be transported. Thus, for example, "pickup and delivery, one man, local," identifies a commodity class by size and type of packaging such as would go in a local pickup and delivery van with one man operating the van. Both vehicle and commodity can be practically identified in surveys. One criterion for the system has been that no category should include less than 1 percent of the total movement. On the other hand, no category should include more than perhaps 10 or 15 percent of the total. Thus, one arrives at something like 25 categories. The system of classification of commodities is important to making progress in urban commodity flow research. It is hoped that this suggestion will stimulate discussion.

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