TOPIC 10
FREIGHT AND LOGISTICS

URBAN GOODS MOVEMENT PLANNING: AN INFORMATIONAL APPROACH FOR MODELLING

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Abstract

Strategic planning of urban goods movement is undertaken, for the Montreal case, by the implementation of a series of quantitative tools adapted to the nature of the usually addressed policy problems (transport economics, impactees, traffic measures, hazardous material transport risks, etc.): classification and origin-destination counts, operator Origin-Destination surveys, truck and operator inventory and categorisation.

FOREWORD

The second phase of the study of the integrated transportation of goods and hazardous materials in the Greater Montreal Area was completed during 1993 by way of a combination of activities meant to increase our knowledge and awareness of this question.

Four simultaneous actions were initiated at the beginning of the year. To begin with, an intensive counting program (classification and origin-destination counts) was set forth by the Ministry of Transportation of Quebec (MTQ), the Montreal Urban Community (MUC) and many participating municipalities. Next, Origin-Destination surveys were conducted of the road and rail carriers by the consulting firms of Beauchemin-Beaton-Lapointe and CANARAIL respectively. During this time, the MADITUC Group at the École Polytechnique designed and created a data management and analysis software (MADGAT) that would structure the diverse components of the information system necessary to implement an additional analysis and strategic planning software, MAD(strat)2—Modèle d'Analyse Désagrégé Stratifié et Stratégique (Stratified and Strategic Disaggregate Analysis Model).

The present paper describes the essential elements of the methodological approach (components of the informational system—carriers, vehicles, activity nomenclature, products—and the modelling triptych—TERRITORY-NETWORK-DEMAND-), as well as a few results derived from the preliminary data obtained from the surveys. Graphical representations of the spatial distribution of the diverse commercial movement markets, as well as summary simulations of the trucking itineraries illustrate certain functionalities of the new tools available to planners.

This text is based on the synthesis of a number of certain documents which have been presented elsewhere. Among them are: the terms of reference of Phase II (produced by the Territory Development Division of the Territory Planning Department of the Montreal Urban Community in collaboration with the Department of Road Transport of Goods of the Ministry of Transportation of Quebec) used in the project *The study relative to the integrated transportation of urban goods and dangerous materials -modelling and data management*, the offer of service and the definitive work schedule submitted by the MADITUC Group of École Polytechnique, as well as the technical paper entitled: "A Totally Disaggregate Approach of Urban Goods Movement Planning" presented at the international francophone congress of the Association pour le Développement Technique des Transports de l'Environnement et de la Circulation (ATEC) at Versailles in October 1993 under the theme "What Kind of Transportation for our Cities of Tomorrow ?"

INTRODUCTION

The multiplicity of the questions contemplated by different levels of public administration in relation to the increasing presence of heavy vehicles in the urban milieu, interpellates the transportation analyst to more complex evaluations than previously was the case. In effect, the issues associated with public security (the appreciation of the risks associated with the transportation of dangerous goods), with the regulation of activity, the cost of congestion on goods movement, the enterprises' location decision (industrial, recycling, or waste management, for example), the environmental or energy problems, as well as the planning of road infrastructure related to urban and dangerous goods movement, demand instruments capable of higher levels of precision and realism than those of traditional models. Incidentally, the traditional models are often merely adaptations of the classical sequential procedure (four-step modelling procedure: synthetic trip generation and distribution models, O-D matrix, simplified networks, etc.) and provide by simulation only the flows on the links in a given network.

It is important to remember that modelling adapted to strategic planning is concerned more with the systems analysis of urban goods movement, policy-planning typically, as described by Ogden (1992), than with the tactical preoccupations found in the context of business logistics.

Following the example of this project, a joint study by the Montreal Urban Community and the Ministry of Transportation of Quebec, related to the integrated transportation of goods and hazardous materials in the Greater Montreal Area was initiated in 1992. Phase II—which took place during 1993—included the execution of two regional Origin-Destination surveys of trucking and rail carriers, numerous classification and cordon counts as well as the development of a data modelling and management program. This latest mandate was granted to the MADITUC Group of the École Polytechnique de Montréal. The proposed, adapted methodology follows an approach derived from an informational change based on an integrated analytical and totally disaggregate method (similar to the philosophy expressed in the MADITUC system—Modèle d'Analyse Désagrégée des Itinéraires de Transport Urbain Collectif / Disaggregate Analysis Model of Urban Public Transportation Itineraries, see Chapleau (1992), Chapleau/Allard (1992), Chapleau (1993)). To accomplish this, two software programs were developed:

- MADGAT (Module d'Acquisition des Données et de Gestion/Analyse et Traitement—Data Acquisition and Management/Analysis and Processing Module): A relational data base system permitting the numerical manipulation of the principal components of an informational system: carriers, vehicles, products, activity categories, territorial districts, multiple spatial references, multimodal networks, land use occupation characterization, transportation movements.
- MAD(strat)2 (Modèle d'Analyse Désagrégée Stratifié et Stratégique—Stratified and Strategic Disaggregate Analysis Model): A system of programs processing the TERRITORY-NETWORK-DEMAND modelling triptych in a totally disaggregate manner, using an interactive graphical framework (AutoCAD Release 12 platform), and a reference system which enables the precise processing of all the accessibility components.

ELEMENTS OF DATA MANAGEMENT WITH MADGAT

The MADGAT module—in its dimension as a shell program—allows for the apprehension of the diverse components of an Information System (I.S.). The following, relatively explicit figures illustrate the architecture of this I.S. as well as the favored methods. Particular attention should be paid to:

- The structure of the components of urban goods movement and of the relational database system. Figure 1 describes the diverse subthemes of the I.S.—carriers, vehicles, products, territorial districts, modal networks, measure of the demand—as well as the classification used for the characterization of carriers' activities.
- The structure of the demand characterization data, obtained from classical counts (classification or cordon counts), Origin-Destination counts and surveys of carriers. Figure 2 sketches a few elements of the procedure used by the Quebec Ministry of Transport to conduct its counts in diverse strategic points in the Greater Montreal Area.
- The enumeration of the road and rail goods transport networks using an informational structure suitable to the MAD(strat)2 interactive graphical system, in which the network elements (streets, arterials, highways, sections...) are represented as a public transit line—which systematizes the processing of the attributes and facilitates the analysis organization (Figure 3).
- The integration of all the available peripheral databases contributing to the analysis; such as for example, the vehicle and carrier registration files and the geographical information system files (streets, addresses, trip generating buildings, territorial district directories, sociodemographic data, etc.).
- The addition of methodological information such as a glossary of terms, a description of the economic activity classification system, geographical land-use maps, industrial park and intermodal terminal maps, a representation of the national and intemational networks, etc.... Figure 4 illustrates some of these aspects.

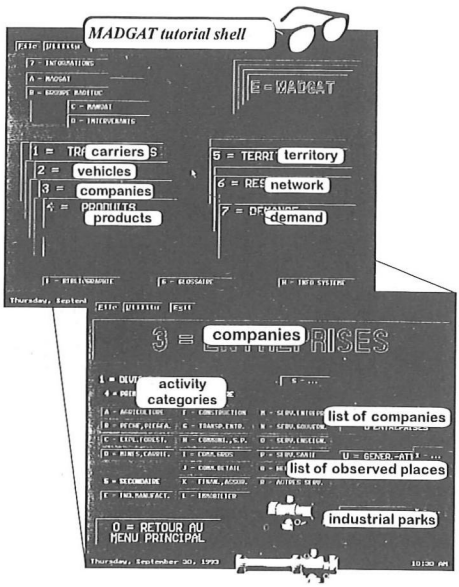


Figure 1 **Subsystems of an informational system: carriers, vehicles, products, territorial divisions, modal networks**

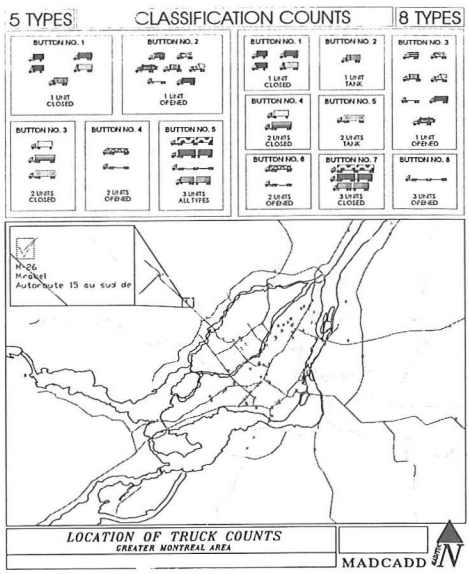


Figure 2 **Truck counts taken at strategic points in the Montreal area**

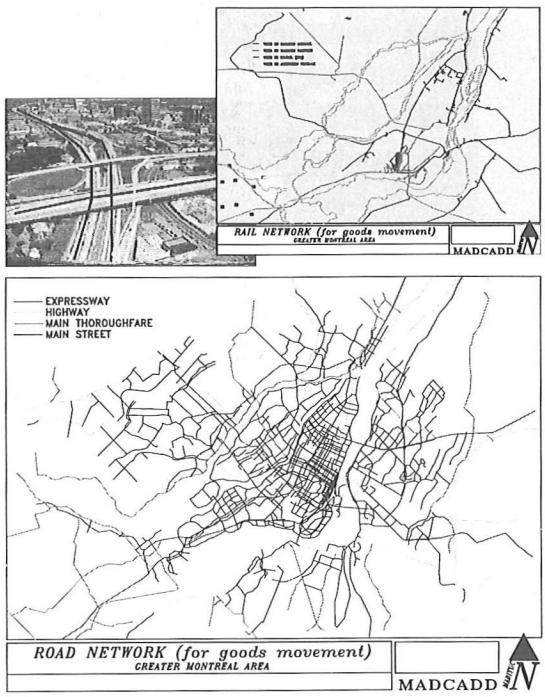


Figure 3 **Road and rail networks used for goods movement in the Greater Montreal area**

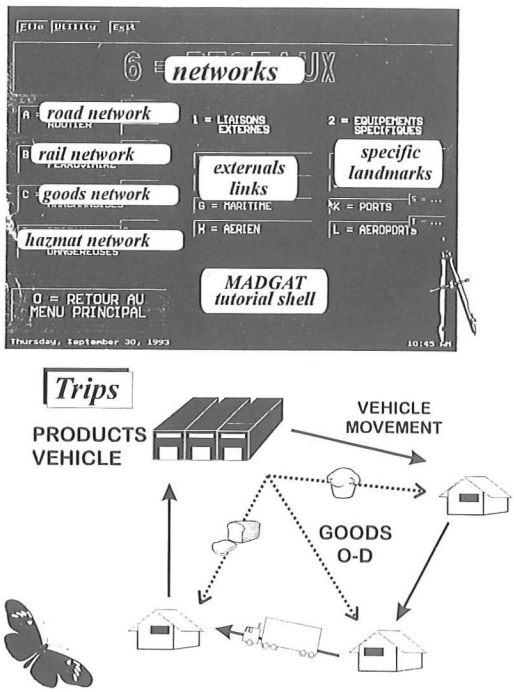


Figure 4 Example of methodological information

THE TOTALLY DISAGGREGATE APPROACH

The totally disaggregate approach involves both the complete, informational processing of all the available elements—that is, a profound processing of the individual trip data—and a precise location reference of the generation and attraction of goods movements; geopolitical or other types of aggregation are accomplished mathematically. Table 1 summarizes the diverse implementation details of the MAD(strat)2 system. The interesting aspects to keep in mind concern:

- the systematic processing of all the spatial reference data;
- the multilayered codification of transportation networks with the aid of a reference medium;
- the support of the multimetric attributes on the networks.

The synthesis table describes the technical particularities incorporated in totally disaggregate informational approach. The TERRITORY-NETWORK-DEMAND triptych is structured in order to accomplish the spatial reference processing of x-y Universal or Modified Transverse Mercator (UTM or MTM) coordinates, which rely on a precision compatible with the postal code (street blockface centroid in Canada) and are inserted on a street grid compatible to the large, national geographical system.

Table 1 Implementation details of the MAD(strat)2 system

TERRITORY	Description of the study area and its external elements: Greater Montreal Area with its provincial, national and international ties.	• Level of territorial precision: fine zones, postal codes (70,000), UTM x-y coordinates • Municipal districts (65), census tracts (700), enumeration areas (4200) • Spatial reference processing of data
NETWORK	Specific intermodal points considered in the study. MULTIMODAL Approach: • road • rail • air • maritime INTERMODAL Approach: • transfer points • warehousing points	• Digitizing and coding of the geometry, intermodal functional connectivity, and levels-of-service (frequency, time, unit costs, capacity, vehicles, relational functions) • Use of the Area Master File—StatsCan—for the location and extraction of the ROAD and RAIL NETWORKS
DEMAND	Spatial quantification of the transportation movements of goods and dangerous matter. MULTIPRODUCT Approach: • according to classification MULTIMETRIC Approach: • volumes in TONNES and MOVEMENTS • by type of VEHICLE	• Creation of aggregated O-D MATRICES for reports, analysis and prospective modelling. • Processing and simulation of the movements in a DISAGGREGATE manner, according to the multiproducts, the multinetworks, the vehicular multimodes

MODELLING IN A DISAGGREGATE CONTEXT

The medium of the disaggregate approach constitutes, first and foremost, a framework of resources oriented toward the interactive analysis of the mass information collected on urban goods movement. This context does not prevent the experimentation of aggregate models provided certain sources of information are of significant character (for example, land use inventory, census data, etc...). The estimation of the trip generation (and attraction) and the trip distribution models can be accomplished in the usual manner, without reducing the disaggregate potentialities.

To appreciate the detailed manner of the diverse functions available with the interactive graphical module, it is necessary to consult the following diagram (Figure 5) in which the possibilities offered to the user are described in the nine primary menus: MADCADD, Territory, Network, Demand, Applications, Utilities, Menu, Demo, Help.

Concerning the actual modelling—the assignment of trips on the network—the schema illustrated in Figure 6 is relatively explicit regarding the type of data taken into account: the consideration of the equilibrium times obtained from a previous equilibrium assignment (automobile trips), in particular.

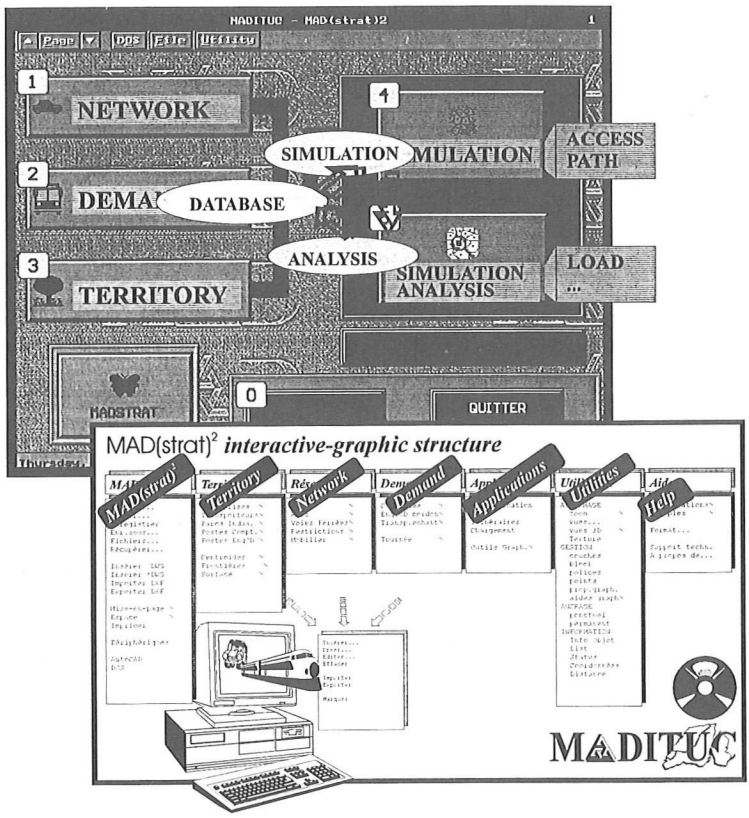


Figure 5 **Interactive computer graphic instrument for strategic planning of urban goods movement**

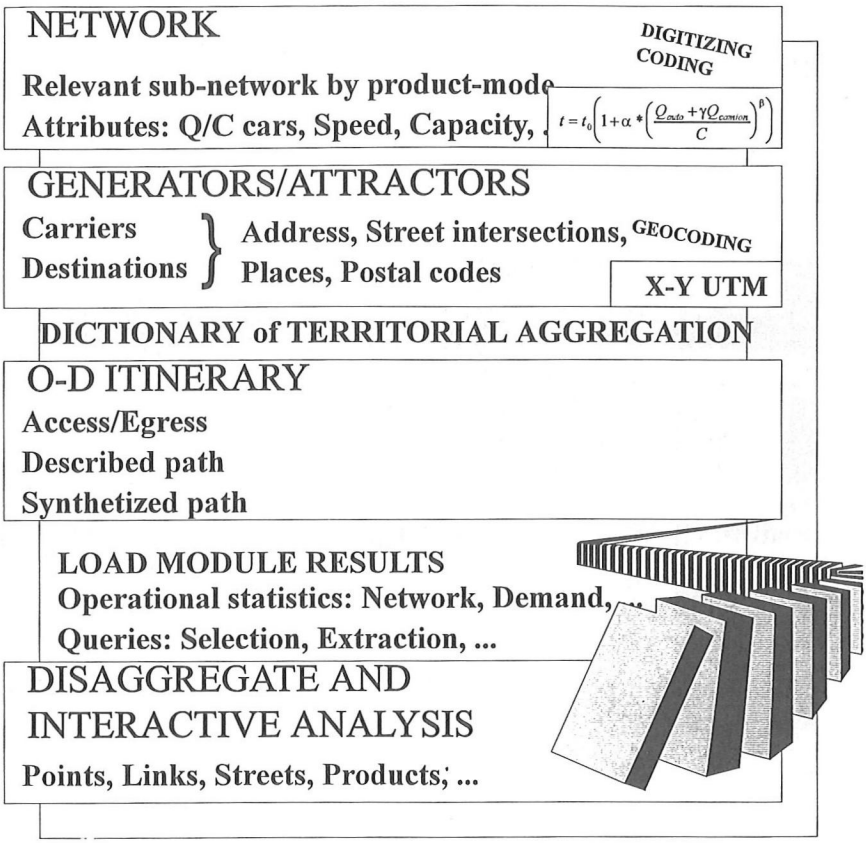


Figure 6 Modelling schema

TYPICAL SUMMARY RESULTS AND FOREGOING POTENTIALITIES

The actual state of the project permitted only crude and summary results. The vehicle registration file from the Société d'Assurance Automobile du Québec (the Quebec Automobile Insurance Corporation) was available for a brief analysis. Taking into consideration certain reservations regarding the representativeness of the information in this file, there was good cause to perform a certain number of investigations with the aid of the MADGAT system. The results of some fifteen searches led to the development of an Excel macro which interactively produces an aggregated image of the actual situation of the goods transport generators in Montreal (see Chapleau et al. 1993). Further, another Excel macro was developed which synthesizes the classification count data for each station. The use of the O-D counts and O-D survey data demonstrates some of the capabilities of the MAD(strat)2 system. The following pages present some elements of this analysis.

The principal menu of the MADGAT's Excel 5.0 macro accessing the results is shown in Figure 7.

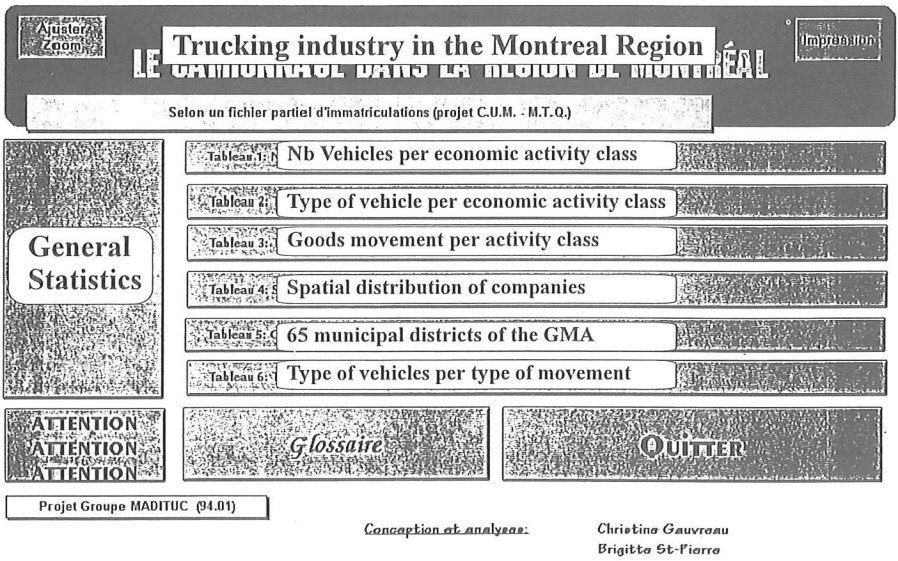
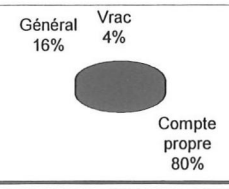


Figure 7 The trucking industry in the Montreal region: presentation of general statistics

Numerous tables of the aggregate results, global statistics

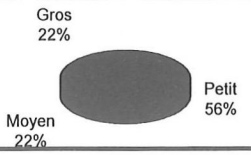
Share of Vehicles per Type of Movement

Private Carriers: 80 %
For Hire Carriers: 16 %
Bulk: 4 %



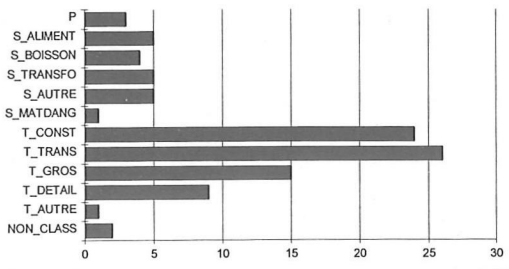
Share of Vehicles by Type:

Small (2 axles): 56 %
Mid Size (3-4 axles): 22 %
Large (5-6 axles): 22 %



Share of Vehicles per Economic Activity Class:

P: 3 %
S_ALIMENT: 5 %
S_BOISSON: 4 %
S_TRANSFO: 5 %
S_AUTRE: 5 %
S_MATDANG: 1 %
T_CONST: 24 %
T_TRANS: 26 %
T_GROS: 15 %
T_DETAIL: 9 %
T_AUTRE : 1 %
NON_CLASS: 2 %



Location of the carriers

The macro CAMION.XLS permits the statistical representation of each of the 65 municipal districts, as illustrated in Figure 8. In summary, the 10 districts in which the vehicles belong to the most important flows are registered:

Municipal district	*Nb of Vehicles*	*% of Vehicles According to GMA*	*Nb of Companies*	*% of Companies According to GMA*
16 - Ville d'Anjou	1095	4%	166	2%
17 - Saint-Léonard	888	3%	260	3%
19 - Saint-Laurent	3059	11%	446	5%
28 - Lasalle	967	3%	158	2%
42 - Longueuil	842	3%	253	3%
54 - Laval-des-Rapides, Pont-	1364	5%	324	4%
59 - M.R.C. Des Moulins	875	3%	420	5%
62 - M.R.C. de Roussillon	1349	5%	465	6%
64 - M.R.C. Vallée Richelieu	876	3%	321	4%
66 - Autres municipalités	1179	4%	460	6%
Total number of vehicles in GMA			**28997**	
Total number of companies in GMA			**8132**	

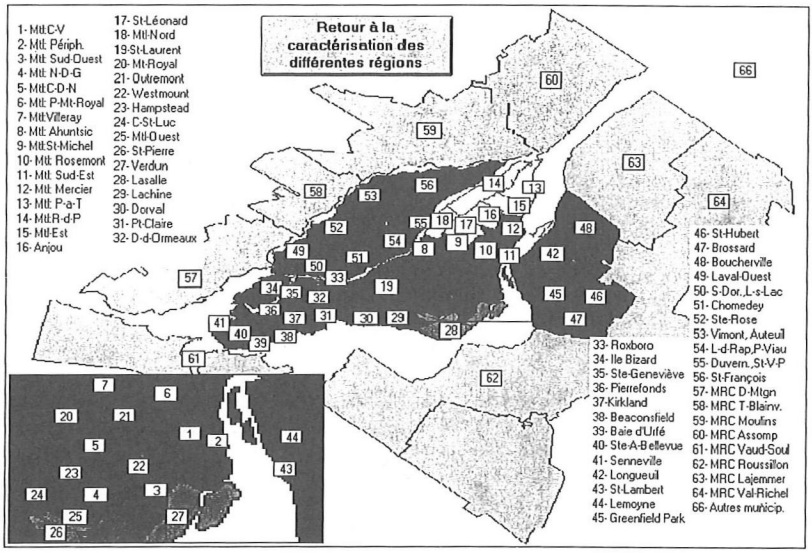


Figure 8 **Graphical interface for statistical analysis of the trucking industry (enterprises, vehicles, economic activity sectors)**

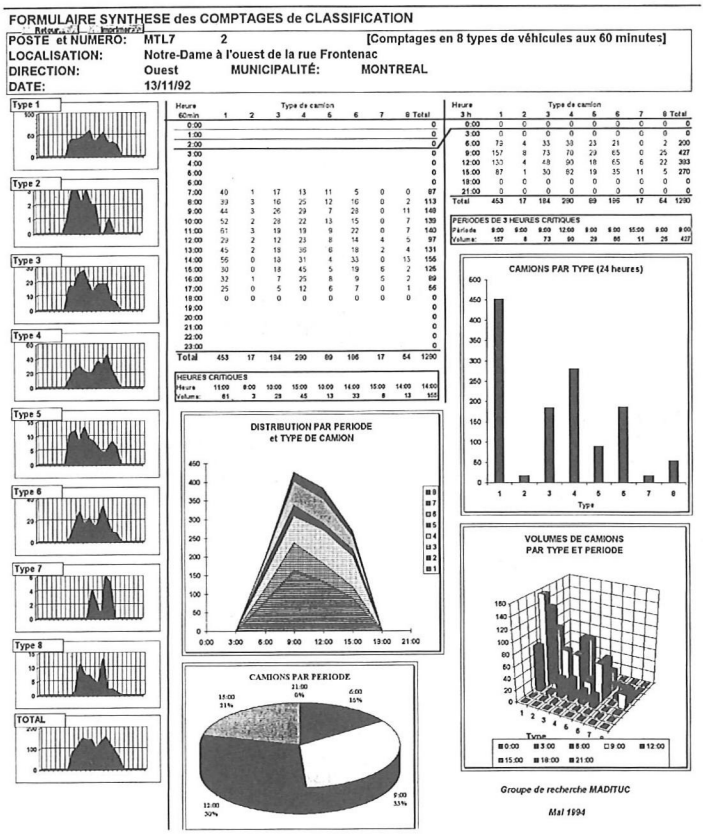


Figure 9 Typical summary of classification counts for each station

The foregoing potentialities of the MAD(strat)2 system are now illustrated, due to the availability of Origin-Destination cordon counts, O-D survey data (carrier, vehicles, pick-up and delivery runs over a main network). Three figures show the potentialities of the system.

- Figure 10 shows the load profile resulting from the assignment of the O-D survey's truck itineraries—operator-based postal survey conducted for the Greater Montreal Area.
- Figure 11 illustrates the "disaggregation functionality" over the load profile of the network links, where different colours (or shades of grey) show the respective proportions of private carriers, for-hire operators and other trucks.
- Figure 12 demonstrates the capacity of isolating a specific operator or vehicle and observing the diverse goods movements (loading and unloading) with a 3D graphical image.

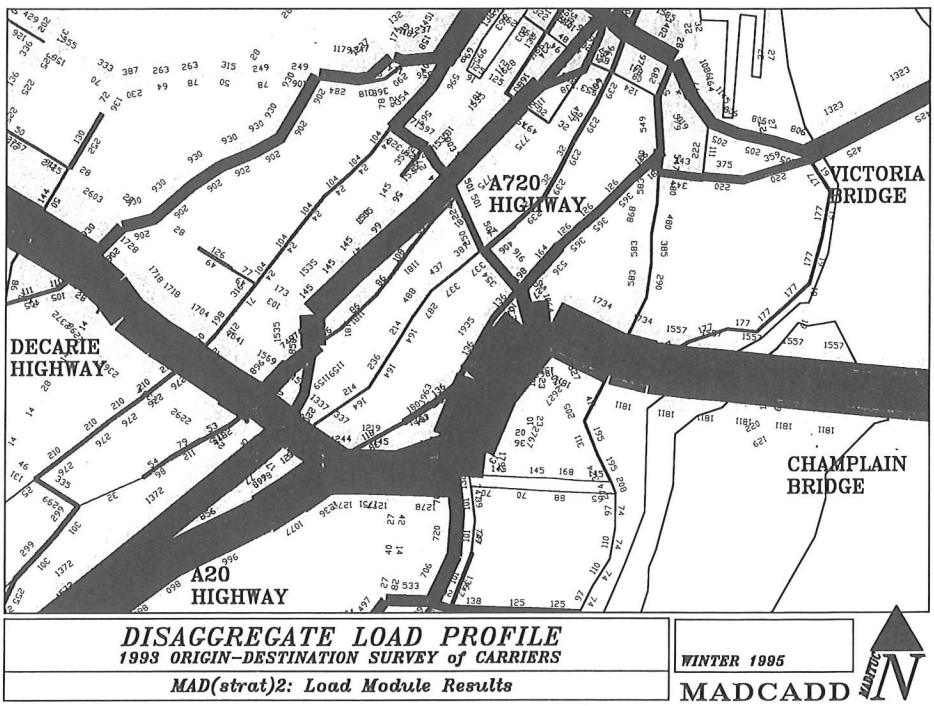
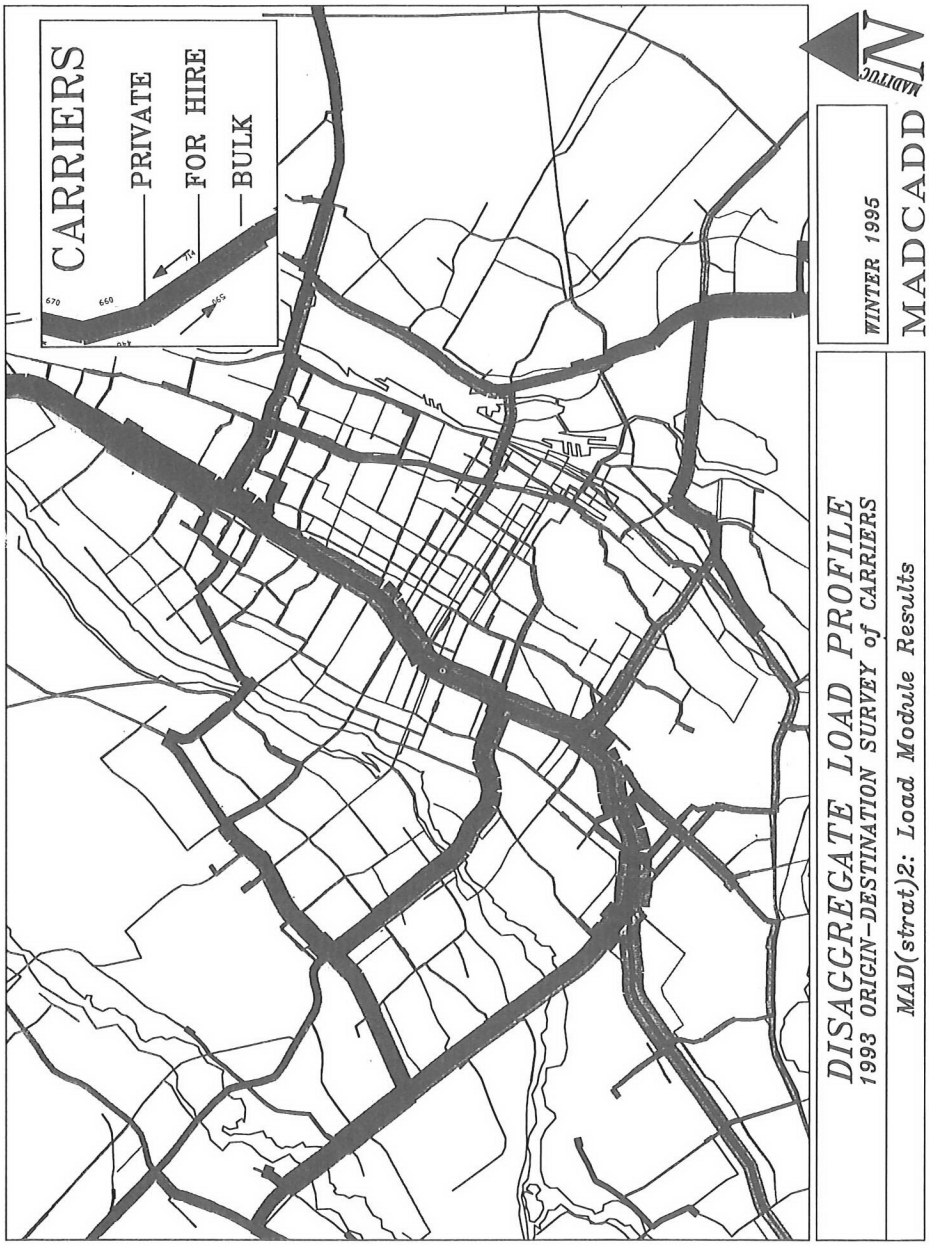
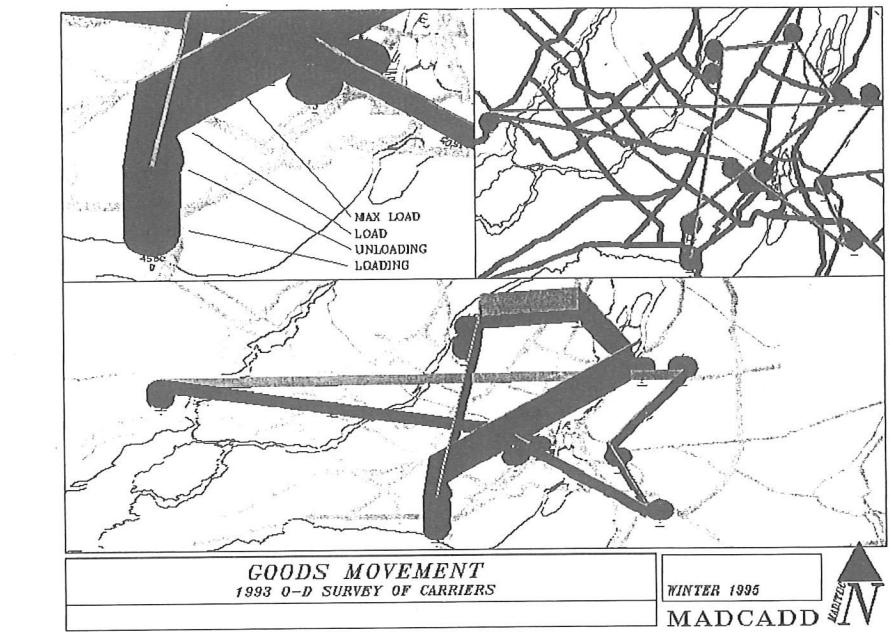


Figure 10 Load profile resulting from the assignment of the O-D survey's truck itineraries



(colours—shades of grey—show the respective proportions of private carriers, for-hire operators and other trucks)

Figure 11 Disaggregation functionality over the load profile of the network links



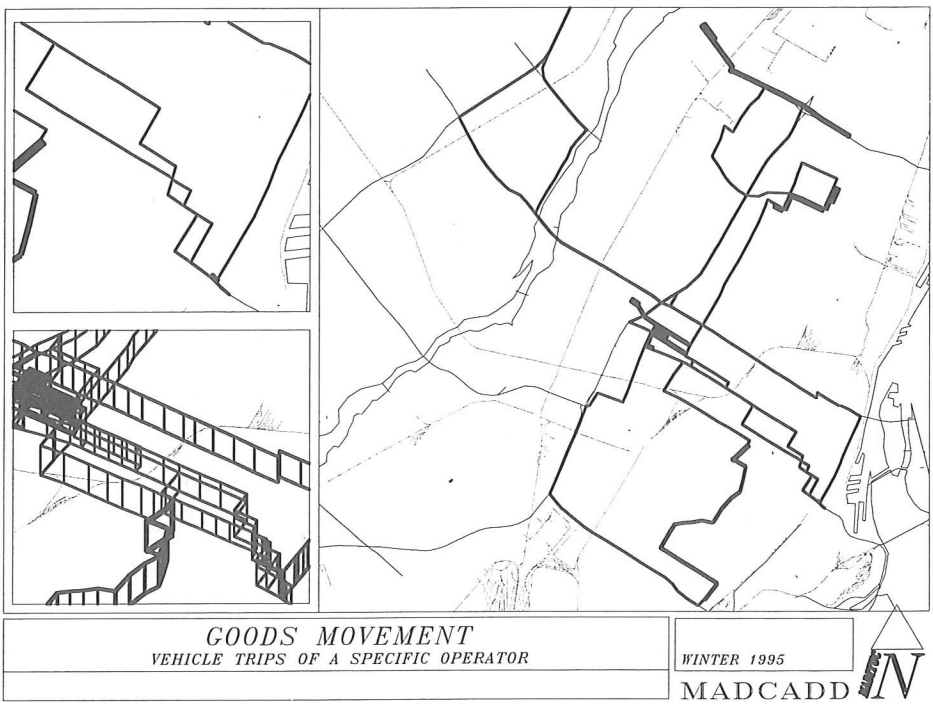


Figure 12 **Demonstration of the capacity of isolating a specific operator or vehicle and looking to the diverse goods movements (loading and unloading)**

CONCLUSION

This paper is an oversimplified presentation of the implementation of the *Totally disaggregate analysis and modelling framework* for the strategic consideration of the urban goods movement in the Greater Montreal Area. In fact, a comprehensive and structured analysis architecture has been developed over the most important interacting entities of the urban goods system: a special G.I.S. (geographic information system) adapted to the hierarchy of the urban goods movement network, a complete database of the vehicle and carriers operating in the area, a structured organization of the Origin-Destination surveys and counts combined with all the necessary facilities and functionalities to conduct all kinds of modelling, within an interactive and graphical microcomputer environment.

Already, it can be concluded that due to the actual microcomputer technology, there is no reason to approach the analysis and planning of urban transportation using models, if the concept of the model uses an oversimplification of reality. On the contrary, in the case of urban goods movement, where the critical questions are still confusing and ambiguous, and where the methodology remains fragile, it is of interest to fashion the future with the potentialities of a totally disaggregate approach which will educate through its cultural medium the future decisions in this sector.

ACKNOWLEDGMENTS

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